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Micelles Hydrodynamics

David V. Svintradze

Free radicals in biology and medicine (EPR investigations)

Eduard Chikvaidze
Section 1 - Department of Mathematics, Inter-discipline (Mathematics, Computer Sciences)

- Mathematical Analysis
- Theory of Probability and Mathematical Statistics
- Algebra-Geometry
- Differential Equations
- Mechanics
- Math. Logic and Discrete Structures
- Numerical Analysis and Computing technologies
Some Properties of Generalized Möbius-Listing’s Bodies

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Based on analytical representation, it is estimated independent elements of the bulky links, which appear after one full cutting of Generalized Möbius-Listing’s Bodies, with radial cross-section – Regular m angular polygon and established:

1. minimal numbers of elements;
2. maximal numbers of elements;
3. the total number of fundamentally different variants

We show possibility of separation of these displacements into the “Elementary permutations”.

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References:


On almost everywhere convergence of generalized Cesáro means of trigonometric Fourier series

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Let \( (\alpha_n) \) and \( (S_n) \) be a sequence of real numbers, where \( \alpha_n > 1, n \in \mathbb{N} \), and

\[
\sigma_n^{\alpha_n} = \sum_{\nu=0}^{n} A_{n-\nu}^{\alpha_n} S_{\nu} / A_{\nu}^{\alpha_n}, \quad A_{n}^{\alpha_n} = (\alpha_n + 1) \cdots (\alpha_n + k) / k!.
\]

(1)

It is clear that \( \sigma_n^{0} = S_n \). If \( (\alpha_n) \) is a constant sequence \( (\alpha_n = \alpha, n \in \mathbb{N}) \) then \( \sigma_n^{\alpha_n} \) coincides with the usual Cesáro \( \sigma_n^{\alpha} \)-means [9]. If in (1) instead of \( S_{\nu} \) we substitute \( S_{\nu}(f, x) \) partial sums of the Fourier series of a function \( f \) with respect to the trigonometric system then the corresponding means \( \sigma_n^{\alpha} \) is denoted by \( \sigma_n^{\alpha_n}(f, x) \).

These means were studied by Kaplan [4]. The author compared the methods of summability \((C, \alpha_n)\) and \((C, \alpha)\), and obtained necessary and sufficient conditions, in terms of the \( \alpha_n \), for the inclusion \((C, \alpha_n) \supset (C, \alpha)\) and \((C, \alpha) \subset (C, \alpha_n)\). Later Akhobadze ([1]-[3]) and Tetunashvili ([5]-[8]) investigated problems of \((C, \alpha_n)\) summability of trigonometric Fourier series.

Now we explore behaviour of \((C, \alpha_n)\)-means of trigonometric Fourier series of integrable functions for sequences \( \alpha_n \).

**Theorem 1.** Let \( 0 \leq \alpha_n \leq \beta_n \). Then \((C, \alpha_n)\) summability of a number sequence \((S_n)\) to \( S \) implies \((C, \beta_n)\) summability of \((S_n)\) to \( S \).

**Theorem 2.** Let \( f \in L(0, 2\pi) \) and \( \alpha_n \to 0 +, n \to +\infty \). Then for almost every \( x \in (0, 2\pi) \)

\[
\lim_{n \to \infty} \alpha_n \sigma_n^{\alpha_n}(f, x) = 0.
\]

**References**


On the modulus of continuity of k-th order of conjugate functions

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In this paper we obtain estimates of modulus of continuity of the conjugate functions of several variables in the space of continuous functions. Exactness of these estimates are established by proper examples.
Sum range of a quaternion series

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In this paper, we obtain a result which implies, in particular, that for a quaternion \( z \notin \{-1,1\} \) with modul one, the sum range of the series \( \sum_{n=1}^{\infty} \frac{z^n}{n} \) is a closed proper subfield of the division ring of quaternions \( H \) isometrically isomorphic to the field of complex numbers \( \mathbb{C} \).
Special Fourier series

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Let \( f(x) \in L(0,1) \) and \( C_n(f) = \int_0^1 f(x) \varphi_n(x) \, dx \), where \( \varphi_n(x) \) is Haar, trigonometric or Walsh system.

Consider the series of the type
\[
\sum_{n=1}^{\infty} |nC_n(f)|^2,
\]
Then

a) In the case of Haar system the series is divergent for some function \( f(x) \in Lip1 \).

b) In the case of trigonometric system the series is convergent for any function \( f(x) \in Lip1 \).

c) In the case of the Walsh system the series is divergent for any non-constant \( f(x) \in Lip1 \) function.
Convergence of general Fourier series

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The sufficient conditions are stated which should be satisfied by functions of orthonormal systems $(\varphi_n(x))$ such that the Fourier series of every function with finite variation is convergent a.e. on $[0; 1]$. It is also shown that the obtained results are best possible in a certain sense.
Absolute convergence of double Fourier trigonometric series

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The absolute convergence of double Fourier trigonometric series is considered. The sufficient conditions for the absolute convergence of double Fourier trigonometric series are established in terms of the modulus of continuity and modulus of variation of a function.
On the strong summability almost everywhere of series with respect to block-orthonormal systems

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In the orthogonal theory it is well-known strong summability method of orthogonal series. Below a question connected with the problems of almost everywhere strong summability of series with respect to block-orthonormal systems are considered.

The series \[ \sum_{n=1}^{\infty} u_n \] is called strong \((C, \alpha)\) \((\alpha > 0)\) summable to the number \(s\) if

\[
\lim_{n \to \infty} \frac{1}{n+1} \sum_{k=0}^{n} (\sigma_k^{\alpha-1} - s)^2 = 0,
\]

where \(\sigma_k^{\alpha}\) are Cesaro means of given series.

Let \(\{N_k\}\) be increasing sequences of natural numbers and

\[
\Delta_k = (N_k, N_{k+1}], \quad (k \geq 1).
\]

Let \(\{\varphi_n\}\) be a system of functions from \(L^2(0,1)\). The system \(\{\varphi_n\}\) will be called a \(\Delta_k\)-orthonormal system if \(\|\varphi_n\|_2 = 1, \ n = 1, 2, \ldots\) and \((\varphi_i, \varphi_j) = 0, \ for \ (i, j) \in \Delta_k, \ i \neq j, \ (k \geq 1)\).

It is established the conditions, when from the a. e. \((C, \alpha), \ (\alpha > \frac{1}{2})\) summability follows strong \((C, \alpha)\) summability of series

\[
\sum_{n=1}^{\infty} a_n \varphi_n(x)
\]

with respect to any \(\Delta_k\)-orthonormal system \(\{\varphi_n\}\).
Maximal multiplier operators in variable Lebesgue spaces

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We study some estimates of norms in variable exponent Lebesgue spaces for maximal multiplier operators. We will consider the case when multiplier is the Fourier transform of a compactly supported Borel measure.

References

On the average number of representations of a natural number by the genus of binary quadratic forms

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By means of the theory of modular forms we obtain formulae for the average number of representation of a natural number by the genus of positive binary quadratic forms with odd discriminant. We show the existence of binary forms which belong to multi-class genera, but for which the number of representations of natural numbers is equal to the average number of representations by the corresponding genus.
Proper representations of (multivariate) linear differential systems

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A proper representation of a linear differential system is a representation with no singularity at infinity. It is shown that such a representation always exists. It turns out that for proper representations having minimal number of rows is equivalent to having minimal total row degree. One is led therefore to a natural definition of the notion of minimality. What is remarkable is that a minimal proper representation is uniquely determined up to premultiplication by a unimodular polynomial matrix of special form. This uniqueness result allows, in particular, to introduce important integer invariants.
On the space of generalized theta-series

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Gooding [1] calculated the dimension of the space \( T(v, Q) \) for reduced binary quadratic forms \( Q \).

In this paper the spherical polynomials of order \( v \) with respect to quadratic form of \( r \) variables are constructed and the basis of the spaces of these spherical polynomials is established. The upper bound for dimension of the vector space of theta-series \( T(v, Q) \) for quadratic forms of \( r \) variables is considered. We have proved the following theorem.

**Theorem 1** The polynomials (the coefficients of polynomial \( P \) are given in the brackets)

\[
P_1(a_{000...0}^1, a_{100...0}^1, \ldots, a_{v-2,v-2,...,v-2}^1, 1, 0, \ldots, 0),
\]
\[
P_2(a_{000...0}^2, a_{100...0}^2, \ldots, a_{v-2,v-2,...,v-2}^2, 0, 1, 0, \ldots, 0),
\]
\[
\ldots
\]
\[
P_t(a_{000...0}^t, a_{100...0}^t, \ldots, a_{v-2,v-2,...,v-2}^t, 0, 0, 0, \ldots, 1),
\]

where the first coefficients from \( a_{000...0} \) to \( a_{v-2,v-2,...,v-2} \) are calculated through other \( t \) coefficients, form the basis of the space \( P(v, Q) \).

**Theorem 2** The maximal number of linearly independent theta-series with spherical polynomial \( P \) of order \( v \) and diagonal quadratic form \( Q \) of \( r \) variables is

\[
\left( \frac{v}{2} + r - 2 \right)^{r - 2}
\]

REFERENCES

Invariant tensors related to isotropy irreducible homogeneous Riemann spaces

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For the class of isotropy irreducible homogeneous Riemann Manturov-Wolf spaces \( M = \mathcal{G}/h \), where the subgroup \( h \) is of the type simple Lie algebra \( B_n, n \geq 2 \), and is a linear group given by the transformation group with the higher weight [1], [2], we constructing \( \mathcal{G} \) - invariant tensors of valence 2, 3, 4. We are calculated the dimensions of given tensor spaces [3].

References


On one problem of American option pricing

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Consider \( (B_n, S_n) \)-market, whose dynamic describe by the model

\[
B_n = (1 + r)B_{n-1}, \quad n \geq 1, \quad B_0 > 0;
\]
\[
S_n = (1 + \rho_n)S_{n-1}, \quad n \geq 1, \quad S_0 > 0,
\]

(1)

where \( r > 0 \) is compound interest rate, \( \rho_n \) take values \( \lambda^{-1} - 1 \) or \( \lambda - 1, \lambda > 0 \). The payoff of an option is given by the expression [1]:

\[
f_{\tau (\omega)} (\omega) = \beta^{\tau (\omega)} \max_{k \leq \tau} S_k (\omega).
\]

In invesnt process we are consider the following type of income (expenses) \( g_n = c_1 \beta_n B_{n-1} + c_2 \gamma_n S_{n-1} \), where \( \pi_n = (\beta_n, \gamma_n) \) is non-self-finansing portfolio, \( 0 < c_1 < 1, 0 < c_2 < 1 \).

The fair price of an option can be written in the form:

\[
C^* = \sup_{\tau} E^* \alpha^\tau f_{\tau} = S_0 \sup_{\tau} \tilde{E} \beta^\tau X_\tau, \quad (2)
\]

where the expectations are taken by the directly constructed martingale measures \( \tilde{P} \) and \( P^* \), and \( X_n \) is some markov sequence.

**Theorem.** The following statements are fulfilled:

a) optimal stopping moment have the following form

\[
\tau^* = \inf \{ n \geq 0 : X_n \in [\lambda^k, \infty) \}, \quad k > 0,
\]

(3)

b) the fair price can be computed by the equality

\[
C^* = S_0 c, \quad c > 0.
\]

(4)

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References

On the Testing Hypothesis of Equality Distribution Densities

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Let $X^{(i)} = (X^{(i)}_1, \ldots, X^{(i)}_n)$, $i = 1, \ldots, p$, independent samples with sizes $n_1, \ldots, n_p$, $p \geq 2$, with densities $f_1(x), \ldots, f_p(x)$ it is required based on $X^{(i)}$, $i = 1, \ldots, p$, samples testing two hypotheses:

- homogeneity hypothesis
  
  $H_0: f_1(x) = \cdots = f_p(x)$

- goodness-of-fit test
  
  $H'_0: f_1(x) = \cdots = f_p(x) = f_0(x)$,

where $f_0(x)$ is known density function. In case of $H'_0$ $f_0(x)$ is unknown.

In this investigation we will construct criteria for testing hypothesis $H_0$ and $H'_0$ against sequence of “close” alternative ([1], [2]):

$H_1: f_i(x) = f_0(x) + \alpha(n_0) \varphi_i \left( \frac{x - l_i}{\gamma(n_0)} \right) + o(\alpha(n_0) \gamma(n_0)), \quad (\alpha(n_0) \gamma(n_0) \to 0),$

$\int \varphi_i(x) \, dx = 0, \quad n_0 = \min(n_1, \ldots, n_p) \to \infty.$

We will consider criteria for testing hypotheses $H_0$ and $H'_0$ based on statistics

$T(n_1, \ldots, n_p) = \sum_{i=1}^{p} N_i \left[ \hat{f}_i(x) - \frac{1}{N} \sum_{j=1}^{p} N_j \hat{f}_j(x) \right]^2 r(x) \, dx,$

where $\hat{f}_i(x)$ is kernel estimator of Rosenblatt-Parzen of density $f_i(x)$:

$\hat{f}_i(x) = \frac{a_i}{n_i} \sum_{j=1}^{n_i} K \left( a_i \left( x - X^{(i)}_j \right) \right), \quad N_i = - \frac{a_i}{n_i}, \quad N = N_1 + N_2 + \cdots + N_p.$

References


Stochastic models with Gaussian martingale. Optimal forecasting.

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Model 1. On the probability space $(\Omega, F, (F_n)_{0 \leq n \leq N}, P)$ we consider the model of risky asset price evolution

$$S_n = S_{n-1} \exp\{I(n < \theta)\Delta M_n^{(1)} + I(n \geq \theta)\Delta M_n^{(2)}\}, \quad S_0 > 0,$$

where, $M_n^{(1)}$ and $M_n^{(2)}$ are independent Gaussian martingales. $\theta$ is the random variable which takes values $n = 1, 2, \ldots, N$. $\pi_i = P(\theta = i), i = 1, 2, \ldots, N$. $M_n^{(1)}$ and $M_n^{(2)}$ are jointly independent of $\theta$, $I(A)$ is the indicator of $A$.

It is proved that kurtosis coefficient of logarithmic return $h_n = \ln(S_n / S_{n-1})$ is positive and formula of optimal in mean square sense $n$-step forecasting estimation $\hat{S}_n(m) = E(S_n / F_m^S)$ is obtained, where $F_m^S = \sigma(S_k, k \leq m), m < n$.

Model 2. On the probability space $(\Omega, F, (F_n)_{0 \leq n \leq N}, P)$ we consider the stochastic process as a model of risky asset price evolution

$$S_n = S_0e^{H_n}, \quad S_0 > 0, \quad H_n = \sum_{n=1}^{n} h_n; h_n = \sigma_n \Delta M_n; \sigma_n = a_n + e^{-b_n} M_{n-1}.$$

Here $(a_n)$, $(b_n)$ are positive sequences of real numbers, $M = (M_n, F_n), M_0 = 0$, is the Gaussian martingale with $EM_n^2 = \langle M \rangle_n$.

In this scheme for any time moment $n$, kurtosis coefficient of logarithmic return $h_n = \ln(S_n / S_{n-1})$ is positive. The covariance $\text{cov}(h_{n-1}, \sigma_n) < 0, n = 1, 2, \ldots, N$, so model has fixed “leverage” effect. Optimal in mean square sense one step forecasting estimation is

$$\hat{S}_n(1) = E(S_n / F_{n-1}^S) = S_{n-1} \exp\{(a_n + e^{-b_n} M_{n-1}) \frac{\Delta \langle M \rangle_n}{2}\};$$

$$M_n = M_{n-1} + \ln \frac{S_n}{S_{n-1}}(a_n + e^{-b_n} M_{n-1}(S))^{-1}, M_0 = 0.$$

References


Stochastic integral representations of Brownian functionals

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As it is well-known from Ito’s calculus, stochastic integral from square integrable adapted process is square integrable martingale. The answer on the inverse question: is it possible to represent the square integrable martingale adapted to the natural filtration of Brownian motion, as the stochastic integral is given by well-known Clark formula (1971). In particular, let \( B_t \ (t \in [0,T]) \) be standard Brownian motion and \( \mathcal{F}_t \) is a natural filtration generated by this Brownian motion. If \( F \) is a square integrable \( \mathcal{F}_t \)-measurable random variable, then there exist square integrable \( \mathcal{F}_t \)-adapted random process \( \varphi \) such that \( F = EF + \int_0^T \varphi_s dB_s \). On the other hand, finding of explicit expression for \( \varphi \) is very difficult problem.

In this direction, it is known one general result, called Ocone-Clark formula (1984), according to which \( \varphi_t = E(D_t F \mid \mathcal{F}_t) \), where \( D_t \) is so called Malliavin stochastic derivative. But, on the one hand, here it is required the stochastically smoothness and on the other hand, even in case of smoothness, calculations of Malliavin derivative and conditional mathematical expectation are rather difficult.

The next step in this direction was taken by Ma, Protter and Martin (1998), they offered the concept of stochastic derivative and generalized stochastic integral for so called normal martingales class and generalized Clark’s formula for functionals from the class \( D_{2,1}^M \) (the functional \( F = \sum_{n=0}^{\infty} I_n (f_n) \) belongs to the space \( D_{2,1}^M \) if and only if \( \sum_{n=1}^{\infty} n! \| f_n \|_{L_2([0,T])}^2 < \infty \) ). We (Purtukhia, 2003) have introduced the space \( D_{p,1}^M \), \( 1 < p < 2 \), \( D_{p,1}^M \) the Banach space which is the closure of \( D_{2,1}^M \) under the following norm \( \| F \|_{p,1} = E(\| F \|_{L_p} + \| DF \|_{L_2([0,T])}) \) and extended the Ocone-Haussmann-Clark formula for functionals from this space. Absolutely different method for finding of \( \varphi \) was offered by Shyriaev, Yor and Graversen (2003, 2006), which was based on using of Ito’s (generalized) formula and Levy’s theorem for associated to \( F \) Levy’s martingale \( m_t = E(F \mid \mathcal{F}_t) \). We (Purtukhia, Jaoshvili, 2009) introduced the new construction of stochastic derivative of Poisson functional and established the explicit expression for the integrand of Clark representation.

In the all cases described above \( F \) was stochastically smooth. We (with prof. O. Glonti, 2014) considered case when \( F \) is none stochastically smooth, but from associated with \( F \) Levy’s martingale one can to select a stochastically smooth subsequence and in this case we gave the method for finding of integrand. Here we consider a different case, when functional represents the Lebesgue integral from stochastically non smooth square integrable process, with respect to time variable.

Theorem. The following stochastic integral representation is fulfilled

\[
\int_0^T I_{\{B_t \leq c\}} dt = \int_0^T \Phi(\frac{c}{\sqrt{t}}) dt - \int_0^T \left( \int_0^T \frac{1}{\sqrt{t-s}} \varphi(\frac{c-B_s}{\sqrt{t-s}}) dt \right) dB_t,
\]
where \( \Phi \) (respectively \( \varphi \) ) is the standard normal distribution function (respectively density), 
\[
c = const.
\]

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Some classes of simple sets

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Tennenbaum (see, [3, p.159]) defined the notion of $Q$-reducibility on sets of natural numbers and Friedberg and Rogers [1] defined the notion of $s$-reducibility.

If $A \leq_s B$ via a computable function $f$ such that for all $x, y, x \neq y \Rightarrow W_f(x) \cap W_f(y) = \emptyset$ and $U_{x \in \omega} W_f(x)$ is computable, then we say that $A$ is $s_{1,N}$-reducible to $B$ (in symbols: $A \leq s_{1,N} B$).

If, in addition, $(\forall x)(W_f(x) \text{ is finite})$, then we say that $A$ is $s_{1,N,f}$-reducible to $B$ (in symbols: $A \leq s_{1,N,f} B$).

Our notation and terminology are standard and can be found in [2] and [3].

Theorem 1. Let $A$ be a coinfinitely c.e. set such that $A$ does not belong to the class $sHS$. Then there is a c.e. set $C$, $C \subseteq A$, such that every c.e. coinfinite superset of the set $C$ is $Q$-complete.

Corollary. $SH \subseteq sHS$.

Theorem 2. For every noncomputable c.e. set $C$ there exist c.e. sets $A, S$ such that $A$ is a hypersimple, $S$ is a simple nonhypersimple and

$C \equiv_T A \& A \equiv Q S \& S \not \equiv_T A$.

Theorem 3. Let $K$ be a creative set and let $A$ be an arbitrary infinite set. Then $A$ is strongly hyperimmune (finitely strongly hyperimmune) if and only if $K \not \equiv s_{1,N} B$ (equivalently, $A \not \equiv s_{1,N,f} B$) for all infinite subset $B$ of $A$.

Theorem 4. Let $A$ be a $\Sigma^0_2$ infinite set and let $K$ be a creative set. Then $A$ is strongly hyperimmune if and only if $K \not \equiv s_{1,N} B$ for all $\Sigma^0_2$ (equivalently, $\Delta^0_2$) infinite subset $B$ of $A$.

Theorem 5. Let $A$ be a $\Sigma^0_2$ infinite set and let $K$ be a creative set. Then $A$ is finitely strongly hyperimmune if and only if $K \not \equiv s_{1,N,f} B$ for all $\Sigma^0_2$ (equivalently, $\Delta^0_2$) infinite subset $B$ of $A$.

References


Some Combinatorial Properties of Hamel Functions

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**Definition:** A function \( f : \mathbb{R} \rightarrow \mathbb{R} \) is called Hamel function if it is a non-trivial solution of the Cauchy functional equation, built by Hamel (see. [1]).

The graph of any Hamel function has one or countably many connected components. We describe these connected components; each connected component has \( 2^{2^{\aleph_0}} \) many automorphisms. There are at most three Hamel functions, such that their corresponding graphs are not isomorphic.

**Reference**

Monadic MV-algebras were introduced as an algebraic model for the predicate calculus QL of Lukasiewicz infinite valued logic, in which only a single individual variable occurs [1].

An MV-algebra is an algebra $A = (A, \oplus, \otimes, *, 0, 1)$, where $(A, \oplus, 0)$ is an abelian monoid, and for all $x, y \in A$ the following identities hold:

$$x \oplus 1 = 1, \quad x** = x, \quad (x* \oplus y)* \oplus y = (x \oplus y*)* \oplus x, \quad x \otimes y = (x* \oplus y*)*.$$

An algebra $A = (A, \oplus, \otimes, *, \exists, 0, 1)$ is said to be a monadic MV-algebra [2] if $(A, \oplus, \otimes, *, 0, 1)$ is an MV-algebra and in addition $\exists$ satisfies the following identities:

1. $x \leq \exists x$,
2. $\exists (x \lor y) = \exists x \lor \exists y$,
3. $\exists (\exists x)^* = (\exists x)^*$,
4. $\exists (\exists x \oplus \exists y) = \exists x \oplus \exists y$,
5. $\exists (x \otimes x) = \exists x \otimes \exists x$,
6. $\exists (x \oplus x) = \exists x \oplus \exists x$.

It is constructed covariant functor $\gamma$ from the category of monadic MV-algebra into the category of $Q$-distributive lattices, i.e. distributive lattices with quantifier introduced by R. Cignoli [3]. For every monadic MV-algebra, it is constructed dual object named $MQ$-space which is a special subcategory of spectral spaces - $Q$-spaces developed by R. Cignoli for $Q$-distributive lattices.

References

Consider the following difference equation

\[
\Delta u(k) + \sum_{i=1}^{m} p_i(k) u(\tau_i(k)) = 0,
\]

where \( m \in \mathbb{N} \), \( p_i : \mathbb{N} \to \mathbb{R}_+ \), \( \tau_i : \mathbb{N} \to \mathbb{N} \), \( \tau_i(k) \leq k - 1 \), \( \lim_{k \to +\infty} \tau_i(k) = +\infty \) \((i = 1,\ldots,m)\) and difference operator is defined by \( \Delta u(k) = u(k+1) - u(k) \). New oscillation criteria of all solutions are established.
On the Well-Posedness of the Cauchy Problem for One Class of Neutral Functional Differential Equation with Distributed Prehistory

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The functional differential equation is considered

\[ \dot{x}(t) = A(t)\dot{x}(t - \sigma) + \int_{t-\theta_0}^{t} f(t, x(t), x(s)) ds, t \in [t_{00}, t_{10}] \] (1)

with the initial condition

\[ x(t) = \varphi_0(t), \quad \dot{x}(t) = h_0(t), \quad t < t_{00}, \quad x(t_{00}) = x_{00} \] (2)

and with distributed prehistory on the interval \([t - \theta_0, t], t \in [t_{00}, t_{10}],\) where \(\sigma > 0, \theta_0 > 0\) are fixed numbers. A theorem on the continuous dependence of solution of the problem (1),(2) is proved with respect to perturbations of the initial data \((t_{00}, \theta_0, x_0, \varphi_0(t), h_0(t))\) and the integrand \(f\) of the right hand side of equation. Perturbation of the initial data is small in the standard norm and perturbation of the integrand is small in the integral sense. Such type theorems are used in proving of the variation formulas and necessary optimality conditions [1, 2].

References


Hierarchical Models for Porous Elastic and Viscoelastic Kelvin-Voigt Prismatic Shells

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The present paper is devoted to construction of hierarchical models for porous elastic and viscoelastic Kelvin-Voigt prismatic shells on the basis of linear theories. Governing systems are derived. In the $N=0$ approximation, considering plates of a constant thickness, the governing system mathematically coincides with the governing system of the plane strain corresponding to the basic two-dimensional linear theory [1] up to an additional equation for the out of plane component of the displacement vector in our cases. The ways of investigation of boundary value problems and initial boundary value problems, including the case of cusped prismatic shells [2], are indicated and some preliminary results are presented.

References

Vekua;s dimension reduction method for the third model of prismatic shells

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In the present talk the static problem for hierarchical model [1,2] for elastic prismatic shells is considered, when on the face surfaces a normal to the projection of the prismatic shell components of a stress vector and parallel to the projection of the prismatic shell components of a displacement vector are known. The problem mathematically leads to the question of posing and solving of boundary value problems for even order equations and systems of elliptic type with the order degeneration. Existence and uniqueness theorems for the corresponding two-dimensional boundary value problems are proved.

References
Algorithmic problems for class-2 nilpotent MR-groups

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In this paper we investigate the basic algorithmic problems for class-2 nilpotent MR-groups. It is proved that, under an additional assumption of finite definiteness, all these problems have a positive solution and, in the general case, they have a negative solution for finitely generated groups.
Construction of unknown full-strength contours for the problem of plane elasticity theory

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The problem of the plane theory of elasticity for a plate with a partially unknown boundary is considered. Absolutely smooth rigid punches with rectilinear bases, which are under the action of the forces that apply to their middle points. Unknown part of the boundary is free from external forces.

Using the methods of complex analysis[1], the unknown part of the boundary is found under the condition that the tangential normal stress on that takes a constant value. Numerical analysis is performed and the corresponding graphs are constructed by Mathcad.

References

One Generalization of Nonlocal Contact Problem for Poisson's Equation in Rectangular Area

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In this paper one generalization of contact problem for Poisson's equation in rectangular area is considered, when nonlocal conditions are stated for the finite number of segments. The existence and uniqueness of a regular solution is proved. The iteration procedure is constructed and investigated. The results of numerical calculations are given.
On nonlocal problem for ultraparabolic equation

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In this paper ultraparabolic equation with two time variables is considered in abstract Hilbert spaces with nonlocal initial condition with respect to one time variable, which connects values of the unknown vector-function at initial and some subsequent point of the interval of this time variable. The existence and uniqueness theorem for the nonlocal problem is proved in suitable spaces of vector-valued distributions with values in Hilbert spaces. An iteration algorithm of approximation of solution of the nonlocal problem by a sequence of solutions of the corresponding classical problems is constructed and investigated. Applying general results obtained for the nonclassical problem in abstract Hilbert spaces nonlocal in time initial-boundary value problem for ultraparabolic equation is studied in Sobolev spaces.
About splitting semi-discrete scheme for an evolutionary equation with variable operator into two-layer schemes

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In a Hilbert space we consider the Cauchy problem for an abstract parabolic equation with variable, self-adjoint, positively defined operator. For approximate solution of this problem, using the perturbation algorithm, implicit three-layer semi-discrete scheme is reduced to two-layer schemes. An approximate solution of the original problem is constructed by means of the solutions of these schemes. The approximate solution error is estimated.
A numerical algorithm of solving a nonlinear Kirchhoff string equation and its error

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We consider the following initial boundary value problem

\[
\begin{align*}
& w_n(x,t) = \varphi \left( \int_0^\pi w_x^2(x,t) dx \right) w_{xx}(x,t), \\
& 0 < x < \pi, 0 < t \leq T, \quad \varphi(z) \geq \alpha > 0, \quad 0 \leq z < \infty, \\
& w(x,0) = w^0(x), \quad w_t(x,0) = w^1(x), \quad w(0,t) = w(\pi,t) = 0,
\end{align*}
\]

describing the oscillation of a string [1]. Its local solution is derived by means of a numerical algorithm consisting of the Galerkin method and a symmetric difference scheme for approximation with respect to spatial and time variables, while the resulting discrete system is solved by the Picard iteration method. The total error of the algorithm is estimated. The global solution case was studied in [2] and [3].

References


A Numerical Solution for the Timoshenko Nonlinear System

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We consider the nonlinear system of equations describing the shell deformation. The system of equations is reduced to one nonlinear integro-differential equation. Using the projection method the infinite-dimensional task is replaced by finite-dimensional one. Existence of generalized solution and convergence of Galerkin method are proved. Resulting system of cubic equations is solved by iterative method. Parallel computing system is used for getting numerical solution.

References

Section 2 - Department of Computer Sciences

- Theoretical Informatics
- Applied Informatics
- Technical Informatics
- Practical Informatics
Algorithms in Computer Topology

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Keywords: Computational topology, efficient algorithms

In this talk, we describe efficient algorithms for particular topological problems.

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Keywords: Discrete optimization, Multicriteria optimization, Vehicle routing problem (VRP)

The paper deals with the vehicle routing problem (VRP) in extreme environment, which is reduced to the bicriteria partitioning problem. The issues of finding weakly efficient (Sleiter) and efficient (Pareto) solutions using ε-constraint method are considered. Branch and bound type algorithm is implemented and its effectiveness is shown.
Logical entropy of Directed Graph's Strongly Connected Components

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Keywords: Strongly connected components. logical entropy

The notion of logical entropy is applied to doubly-sided reachability relation vertices. C++ program to find of logical entropy of strongly connected components is given.
The balance algorithm for RB-tree

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Keywords: RBT, AVL, hybrid data

Hybrid data structure is very closely related to the existing balance algorithms. Hybrid RB tree means that in some cases, only for a short time, colour field has different function, which gives us abilities that RB tree doesn’t have. Though, the knot structure remains unchanged. The RB tree operations are conducted in guaranteed logarithm time. Although, searching operations are relatively slow comparing to the AVL tree. If it happens in practice that the long process of adding and deleting of the knots, followed by a long searching process, etc. occurs, then it is preferred to transform RB tree into AVL tree before the searching operation and counter transformation may be done only if necessary. The transformation into AVL tree will occur by circling in inorder style of the initial tree and the taking of knots from the RB tree by increasing numbers and putting them into AVL tree by the same principle. In fact, the use of Day’s algorithm for the re-balancing is the same as transformation into AVL tree with the precise details of the implementation). There is no technical obstacle; when it comes to programming, everything is done within the same class, which is united with the one mode field. The structure of the knot remains unchanged. There are two fixups for the adding and the same amount for the deleting – according to the regime. RB tree and AVL tree are different only by this fixup. There are also algorithms to transfer them in each other. One of them means the re-balancing of the RB Tree with Day’ algorithm.
Automated knowledge bases construction

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Keywords: knowledge fusion, semantic similarity, semantic similarity measure

Automated knowledge bases construction The article address the knowledge bases (knowledge vault) automated design issues. It is underlined the most important aspects like Knowledge fusion from various sources, Facts trustworthiness probabilistic model, texts semantic analysis (semantic similarity, semantic similarity measure, synonyms). The problem solution role analysis in order to construct large scale knowledge warehouses.
New aggregation operators in multi-criteria decision making methods

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Keywords: aggregation operators, fuzzy decision making methods
New aggregation operators for the fuzzy intuitionistic anf fuzzy hesitant environments are constructed.
Designing a Decision Making Support Information System for the Operational Control of Real Industrial Technological Processes

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Fuzzy logic is a new and innovative technology that was used in order to develop a realization of engineering control. In recent years, fuzzy logic proved its great potential especially applied to automatization of industrial process control, where it enables the control design to be formed based on experience of experts and results of experiments. The projects that have been realized reveal that the application of fuzzy logic in the technological process control has already provided us with better decisions compared to that of standard control technique. Fuzzy logic provides an opportunity to design an advisory system for decision-making based on operator experience and results of experiments not taking a mathematical model as a basis. The present work deals with a specific technological process – designing a support decision making information system for the operational control of the lime kiln with the use of fuzzy logic based on creation of the relevant expert-objective knowledge base.

References
On the construction mixed strategies in fuzzy matrix games

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Keywords: fuzzy matrix game, mixed strategies

Sometimes it is possible to acquire certain personal, psychological data about an opponent. Such information, as a rule, is of fuzzy nature, and it can be depicted by fuzzy linguistic variables. The method of construction of mixed fuzzy strategies for antagonistic games with fuzzy information is considered. Using the fuzzy logic rules the numerical example is studied.
On the asymptotic properties of one class stochastic finite automaton in a ternary stationary random medium

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Keywords: finite automaton, stationary random medium, behavior algorithm, the Markov chain, eigenvalues.

Is proposed algorithm behavior of one class of finite stochastic automaton in stationary random medium with three possible reactions (win, loss, indifference). Is studied the eigenvalues of Markov chain which describes the behavior of the automaton in this medium. We prove the uniqueness of eigenvalue, aspiring to 1 in modulus with increasing the memory capacity automaton and is estimated speed of convergence.
Using the Modified Hill's Algorithm for Construction New Tweakable Cipher

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Keywords: Hill's modified algorithm, tweakable cipher, avalanche effect.

The paper discusses the possibility of using the Hill's modified algorithm for construction a new, tweakable type block cipher. In particular, it is shown, that by using this algorithm, very quickly achieved avalanche effect and in development of one output bit involved maximum quantity of entrance bits. The output and input bit strings are independent.
Fuzzy Modeling of the Vehicle Routing Problem for Extreme Environment

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Keywords: Vehicle routing problem, multiple-criteria optimization, possibility theory, fuzzy partitioning problem.

In the extreme and uncertainty environment the difficulty of vehicle movement between different customers cause the imprecision of time of movement and the uncertainty of feasibility of movement. In this work this uncertainty is presented by a possibility distribution. A new multiple criteria fuzzy optimization approach for the solution of the vehicle routing problem is constructed. A new subjective criterion – maximization of feasibility of movement on closed routes is constructed. The problem is reduced on the min-max bicriteria fuzzy partitioning problem for the so called promising routes. For the numerical solution of the scaling model Christofides exact algorithm is realized. For the illustration of the results of the constructed new fuzzy approach a numerical example is presented.
Social media and web design

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Keywords: Web design, Social Networks

The modern society and Internet become inseparable today, while Internet without social activity seems to be whole less. Networks like Facebook, Tweeter, LinkedIn, unite millions of people actively participating in various activities. Developers and owners of websites are trying to promote their pages and thus business effectively and actively using social signals for SEO. In the work the impact of social activities are discusses along with paid media application tendencies for better ranking.

References
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The Classification or Medical Records for EMR (Electrical Medical Records) System

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Keywords: EMR, classification

The introduction of EMR (Electrical Medical Records) system had a significant impact on development of health services worldwide. The process has been started recently in Georgian health system. The most medical records are saved in free text, .doc or .docx format files nowadays. The problem of medical condition defining document structuration and classification is stated. The mentioned issue might be presented as a particular problem of text classification. Natural Language Processing (NLP) is one of the best tools for solution. The article address main methods necessary for appropriate software development (one that structure and classify some type medical records) in order to import them later in EMR system.
Georgian Language Based Document Classification Method Development

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Keywords: text processing, text classification

The problem of Information Retrieval is complex and the stage of classification is one of its important initial process. The stemming and lemmatization algorithms appropriate to Georgian language is developed. Particularly the word root defining algorithms for Georgian language were produced. Appropriate software was developed and tested. For the process of testing the collection of Georgian language based text was developed presented in form of database. The text processing modern algorithms were adopted for Georgian text initial compilation and the new algorithm was proposed for consideration. The developed software allowed construction of the appropriate knowledgebase. The part of initial text collection was used for knowledgebase formation.
Medical Texts Initial Processing for Classification Problem

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Keywords: text processing

The issue of classification is one of the important directions in information retrieval. Text type information in medical science plays a significant role. Text classification process has to contain text initial processing that means: “stop words“ filtering out from the text, stemming and lemmatization, followed by word frequency calculations. The procedure of stemming and lemmatization is fulfilled using the well-known algorithms of Lovins and Porter, that are less effective for Georgian Language due to language complex structure. The word “root” defining algorithm is offered proper for stemming and lemmatization. The algorithm uses the word database. Because of peculiarities of medical branch the database future update with appropriate medical terminology is needed. In the process or research the mentioned database of Georgian words was updated using additional medical terms corresponding to ICD10.
On “mobile” Web Design

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Keywords: design, responsive, adaptive.

The term “mobile” web design in our case unites Adaptive and Responsive web design. Sometimes these two notions are described as the same, but in fact it is not true. We will be presenting comparative analysis of these two types of design, first will introduce their definition and underline the actuality of issue, provide pros and cons of each for users and developers, and give some recommendations on application of each for different cases.
Hypervisors, Its vulnerabilities and safety of information

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The hypervisor is basis of virtualization, ensuring safety of information and operates the virtual computer. The problems connected with safety of virtualization in cloud computing demand the analysis and the relevant decisions. In the paper influence of technical characteristics of a hypervisor on safety of information is considered. Characteristics of types of a hypervisor with different parameters providing their efficiency are presented. Recommendations are provided. Also, in the paper the vulnerabilities of a hypervisor on the virtual machine Vmware vSphere example is considered and requirements for the organization of its security.
Idea management system

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Keywords: An idea management system, IMS, Idea management technology

In the Report an idea management is presented, as one of the important means of improvement of innovative activities in the corporation. An idea management system (IMS) is an application, by means of which, using pre-planned, controlled and methodically robust procedures, the idea, from the very phase of its initiation, undergoes the phases of analysis, assessment and if desired, publicity. Idea management technology represents innovative software, which assists organization in collecting new ideas, their assessment and preparation for taking to the market. By using software packages of this type, these activities are performed quickly, efficiently and fruitfully. And more importantly, the system allows risk assessment. Notwithstanding the short history of their development, there are number of idea management systems in software market presently. The existing software packages are characterized by different typical features and abilities. The Report will cover the evolution of idea management systems, typical features and the best applications, widely spread at present.
Routing Protocols and Models in Wireless Ad Hoc network

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Keywords: Ad Hoc Networks, Dynamic Source Routing (DSR), Ad Hoc On Demand Distance Vector (AODV), Optimized Link State Routing (OLSR).

Ad Hoc Networks considered as technical systems whom their instrumentation design is the most important factors, This work presents and provides a detailed analysis of these important characteristics. Ad Hoc network is a combination of wireless mobile nodes. Which creates a temporary network without any network infrastructure administered by a central control. Routing protocols are used in these networks, to learn automatically the mobility and power requirements of Ad Hoc network topology changes, the possibility to change the characteristics of respective nodes. The research investigates the models; dynamic Source Routing (DSR), Ad Hoc On Demand Distance Vector (AODV), Destination-Sequenced Distance Vector routing (DSDV), fish-state routing protocol (FSR), Optimized Link State Routing (OLSR) Routing protocols.
Application of fuzzy TOPSIS approach with linguistic expert assessments

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Keywords: Multiple-attribute group decision making, TOPSIS approach, linguistic variable, triangular fuzzy number.

This work develops an evaluation methodology for multi-attribute group decision making problem based on the TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) method in fuzzy environment. A more realistic approach may be using linguistic expert assessments (linguistic variables) instead of numerical values. In the proposed methodology both the values and weights of the attributes take the form of linguistic terms, given by all decision makers. Then these linguistic terms are expressed in triangular fuzzy numbers. According to the concept of the TOPSIS, a closeness coefficient is defined to determine the ranking order of all alternatives by calculating the distances as to the fuzzy positive-ideal solution (FPIS), as well as to the fuzzy negative-ideal solution (FNIS). An example is shown to explain the procedure of the proposed methodology.
Sparse Matrix Storage new format and its efficiency

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Keywords: Sparse matrix, Conjugate gradient method, Compressed matrix - row major orientation

To represent a sparse matrix, we store its non-zero elements in a dynamical array. We also store a matrix of indexes, which establishes a relationship between the new format and the traditional dense matrix. Unlike usual efficient formats of sparse matrix storing, we are using more memory, but not more than 2 times. Though, with respect to dense matrix, the new format is still much more effective. To benchmark the efficiency of the new format with existing effective formats, the new format is compared with sparse matrix of "boost" library. The conjugate gradient method is used for the quadratic functional. The corresponding program is tested on 70 sparse matrixes, taken from the internet. Changing the data structure, on almost all tests new format is significantly fast. The corresponding project is done in C++. The code of conjugate gradient method is very simple. Parts of the program, responsible for processing the collection of tests and storing data are complicated and cumbersome.
A Strategy for evaluating a Haskell template in parallel

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Keywords: Functional Programming, Parallel Programming, The Generalized Forms.

The parallelism in Haskell represents the natural an reliable usage of calculating cores with following properties:

• The parallel programing id determined. This means that it’s possible to repair parallel program in parallel without execution.

• The parallel program is a multilevel and declared, the have no direct connection with such a mechanisms as synchronization which is message.

As more abstract the program is as it’s a simple to execute it on the parallel software. However it should be taken in account the quality of specification and dependence on data.

The model of parallel programing and the strategy of calculations

Lazy evaluations is a mechanism, which is being used for calculating expressions. The idea is that the calculations are being performed when there is a necessity. more precisely the calculation of arguments is being performed only in way and in time when it will be a strong necessity to reach a results. For example: after choosing first element of list the other part of the list is not necessary and it gives an opportunity to avoid in HEAD (1 : ones) impression the next calculation of ones endless list. Generally we have the following property: in case of using lazy calculations the expressions are being evaluated according to that context in which they are being used.

How to represent the “map” function, using the “Idea” which has following definition

map: : ( a->b)->[a]->[b]
map f [] =[]
map f (x:xs)=f x : map f xs

The lazy data structure which is been created for “map” function and in which is evident two “ideas” can be written:

map:: ( a->b)->[a]->[b]
map f [] =[]
map f (x:xs)=let
    x' = f x
    xs' = map f xs
in
    x': xs'

The templates for the defined tail recursion code can be represented as:

f [ ] = g1 [ ]
f ( x : xs ) = g2 ( g3 x ) ( g4 ( f ( g5 xs ) ) )
g1, g2, g3, g4, g5 functions are depended on the program’s conditions:
g1 – is the function, to process empty list
g2 – is the function, which combines the tail and the top of the list.
g3 – the function, which processes the top of the list.
g4 – is the function, which processes the recursion call for not empty list’s
g5 – is the function, which is processing the tail of not empty list for recursion call
It’s possible to represent for example function “last” which returns the last element from list with following example:

```haskell
last :: [a] -> a
last [x] = x
last (\_:xs) = last xs
```

```haskell
g1 _ = error
g2 a b = b
g3 x = x
g4 x = x
g5 x = x
```

The template of the list is being represented using the “idea”

```haskell
ListTemplate [] = g1 []
ListTemplate (x : xs) = g2 (g3 x) (g4 (ListTemplate (g5 xs)) )
ListTemplate :: [a]->b
ListTemplate [] = []
ListTemplate (x:xs) = let x’ = g3 x
x’’ = g5 xs
x’’’ = ListTemplate (x’’)
x’’’’ = g4 (x’’’)
in
  g2 (x’:xs’)
```

**Conclusion**

Nowadays the most important is the issue of creation such as program code which can be processed in parallel on several cores of one processor or on several computers. In the times when the computers with several cores is available for everyone, creation such a applied program which will effectively use several streams is still a big issue.

Functional programming gives an opportunity to noticeably simplify parallel programming. It’s happening because in functional program are memory areas which are being used by several streams at the same time. Each function works with data which has been received from it’s input. In spite of said before, the issue of effective dividing of calculations in different streams still exist.

**References**


The algorithm of the automatic formation of hyponymy tree for the Georgian GeWordNet lexicon

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Keywords: Electronic Thesaurus - WordNet, SynSet, Hyponymy tree.

The report describes WordNet Thesaurus for Georgian language - GeWordNet. Given the prospects of using the Thesaurus. We discuss the algorithm of automatic formation of hyponymy tree for Georgian dictionary - GeWordNet.
About Project The Company Wolfram Research: "Tweet-a-Program"

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Keywords: Wolfram Research, Wolfram Language, Tweet-a-Program, Wolfram Cloud, Wolfram Alpha, Wolfram Programming Cloud, Wolfram Mathematica

In the Wolfram Language a little code can go a long way. About Project The Company Wolfram Research: "Tweet-a-Program" - It is interesting programs in Wolfram Language, the length of which does not exceed 140 characters. Now that we have tweetable programs, let’s go find what’s possible.
Section 3- Department of Geography

- Hydrology, Oceanology, Meteorology
- Regional Geography and Landscape Planning
- Geography of Natural Management
- Soil Geography
- Geomorphology and Cartography
Agro-Landscape Zoning of West Georgia By using Multifactor (complex) method

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A landscape-multifactor method has been developed and established in West Georgia for agroresource potential spatial distribution regularities for Tangerine. The emphasis was made especially for the components (relief, climate, soils), having substantial impact on the growth and yield of citrus. Morpho-metric analysis (biometric indicators, end of fetal maturity, starting of maturity, frost resistance, etc.) of frost resistant Tangerine - Tiakharu Unshiu from Japan and Saadreo and Adreula (Early ripe) has been conducted. For the application of landscape multifactor (multicomponent) method, which takes into account the role of each component in the spread of citrus, the most important parameters are the following: relief (dismemberment, slope, aspect), climate (temperature inversions, sum of active temperatures, hydrothermal coefficient, etc.), soil conditions. Using this method and morphometric analysis, it became possible ranking of frost resistant tangerine (GIS-technologies) based on the landscape, the result of which has been determined that the frost resistant tangerine varieties in western Georgia has a high yield in the higher subtropical zone.
About Some Maps of Alexandre Aslanikashvili

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Keywords: Alexandre Aslanikashvili, Cartography, Map

Scientific researches of Al. Aslanikashvili clarified the cardinal problems of theory of cartography and methodological issues of mapping. He laid the foundation for the concept metacartography and metacarto-semiotics. This work still has not lost its value and they were translated into different languages.

He created and edited a lot of maps. His cartographic works are of great importance even today. Among them are the maps included in the Atlas of Georgia (Tbilisi-Moscow, 1964). With Al. Javakhishvili he developed the structure and model of atlas. Here are 22 maps (scales 1,500,000 and 2,500,000) made by Al. Aslanikashvili: population size, ethnic structure, land fund, water bodies, agriculture, economics of Georgia, etc.

It is worth pointing separately the maps with the historical context (with co-authors). Such maps are:

- Aslanikashvili Al., Berdznishvili M., Shoshiashvili N. Kingdom of Georgia in XIII century. scale 1:2,500,000;
- Aslanikashvili Al., Dumbadze M., Meskhia Sh. Kingdom of Georgia in XVIII century. scale 1:2,500,000;
- Antadze K., Aslanikashvili Al., Antelava I. Territory of Georgia within the Russian Empire at the End of XIX century.

Besides these, Al. Aslanikashvili made 2 maps with co-authors:

- Georgia, 1914. printed in Encyclopedia of Georgia [1981];

Cartometric and geographical analysis of these maps allow to reveal historical transformations of:
- state borders;
- administrative-territorial divisions;
- place names;
- demographical situation.
To sources of the theory of cartography - Alexander Aslanikashvili

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Theoretical fundamentals of cartography are investigated in 70-their years of the past hundred-flying. Creation of the theory of cartography communicates with a name of Alexander Aslanikashvili. In a basis of the theory of cartography its so-called big triad lies: subject, method and language. A. Aslanikashvili the concept called "Metacartography". It, doctrine about a subject, a method and language. According to this concept the cartography it is discussed science about concrete space of subjects and phenomena of objective reality and its temporary change. The concrete space is an order of interposition of subjects and the phenomena of objective reality as among themselves, and with a spatial reference system (a coordinate grid). In methodology of cartography cartographical forms are investigated: comparisons, analysis, synthesis, abstraction, generalization and modeling. In the theory of cartography the important place is taken by a scale question. Author of this conception And. Aslanikashvili investigated scale space as extent of abstraction; the contents scale as extent of generalization also raised a question of time scale. In Aslanikashvili's theory the important place is taken also by a card language question. The author investigated semyotical aspects of language of the card and connected questions of the theory of cartography with semiotics questions. With a name of A. Aslanikashvili it communicates kartosemiotics researches which became further Bol aktualry. In Aslanikashvili theory the original scheme of internal structure of cartography is offered. In the same place the scheme about the provision of cartography in classification system of sciences and forms of a relationship of cartography with other sciences is submitted, also original scheme of classification of cards is submitted.

A. Aslanikashvili devoted separate researches to questions about historical unity and system essence of geography and cartography. The latest work of the famous theorist which is published in 1981 is devoted to the Emy question.

It should be noted that A. Aslanikashvili Yaponskimi's metacartography is translated by cartographers in Japanese, and for the West European cartographers, key questions of this concept and in the present don't lose the relevance.
Natural Environment  Zoning of West Georgia for Spreading New Varieties of Tangerine in Order to Reveal Optimal Regions

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Based on the metrics suspended in factors area, techniques for agricultural coverage of the territory and rational planting of the citrus of humid subtropical zone of the west Georgia, including verification of their agro potential were developed. Morphometric analysis (biometric index, starting-ending point of the first and second growth, starting-ending point of blossoming, starting of ripening and massive ripening, harvest, mechanical and biochemical composition of the fruit, tasting, storage properties, cost-effectiveness and frost (winter) resistance) of the tangerine – Tiahara Unshiu, introduced from Japan was accomplished.

Aforementioned techniques helped to allocate and differentiate various resource territories, following the resemblance with the virtual model-object and allocation of the landscapes with and administrative units with optimal agro potentials. Data was processed and visualized through GIS – technologies.
landscape- ecological Situation in the Region

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On the basis of geochemical analysis of underground and surface waters, soil and air in technogenesis zones, we have concluded that here we can trace rather strong transformation of natural-territorial complexes and of certain components (mainly on the genocide level) and deterioration of ecological situation. High concentration of chemical substances can be observed very near to the ore body (100-200m), in other radial zones activity of chemical substances is rather weakened and impoverished in the view of ingredients. Ecological zoning of the mountainous regions was carried out according to the above mentioned.
The mystery of the Earth’s Mantle- Myths and reality.

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Key Words: Ringwoodit, Mantle, Diamond, Mantle Ocean

From the 90s of the last century the idea about the existence of a large amount of water (approximately 20 billion cubic meters) in the mantle appeared in the Western Literature. Only recently the hypothesis was proved. American scientists, especially the group led by Michael Woiceshyn (Associated Professor of Washington University in Saint Louise) a few years ago was proving that oceans exist under the Earth Surface, in the upper Mantle, approximately in 600 km depth. They relied on the data taken by 600 0000 seismographs in different parts of our planet. According to obtained data, it was proved that the speed of P waves decreased greatly at a particular depth in the mantle. “The new discovery totally has changed the idea about the structure of the Earth” argued the scientist Steve Jacobsen. This type of character is common for the waves, which are moving through water layers. Based on the data Michael Woiceshyn argues that under the world’s two big regions- Eurasia and North America there are huge water basins.
The popularization nature monuments in Rioni river basin

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Georgia is a country of geomorphological contrasts. A wide variety of hypsometric and morphological terrain forms: deep canyons, subterranean labyrinths, flat plains, different altitude plateaus, high mountains, ranges are present on its surface. In this regard, Rioni basin is a very interesting region.

Natural monuments are unique, being represented by only a few exemplars. They are often being damaged, sometimes completely destroyed. Because of all this, rare and unique creatures of the nature are lost, without any possibility of restoration. We need to develop an integrated programme for their conservation, protection and usage. The basic purpose of this research is to study natural monuments and ensure their popularization. Study of natural monuments with the aim of their popularization is an important issue in our country. This basin is so rich with different endogenous forms that there is a possibility to discover/study new objects which are known for the locals only.

Some of the remarkable monuments are the objects of local or international importance, but they sometimes lose their natural beauty as a result of human intervention. Therefore, it is necessary that natural phenomena of such importance have a status of natural monument.

Many natural monuments in Georgia have been damaged or completely destroyed over the last years. Natural monuments need to be registered and protected, so as to maintain natural phenomena. Numbers of unique natural monuments are not well-arranged and protected. If they are promoted properly, nature objects can be included in tourist and excursion routes.
Georgian geographic knowledge is ancient and the 18th century is considered as its flourishing period. But starting the foundations of the geographic science school is connected to academician Al. Javakhishvili. Developing Georgian scientific language and inculcating the geographic terms is also a part of the 20th century. A Scientific Geography is being founded at that time, by returning of young anthropologist Al. Javakhishvili from Russia to Georgia and by establishing the first Georgian university. The need for inculcation geographic terms arises. The process mostly involved translating terms from other languages, but occasionally some terms needed coming up with nonexistent matching words and ensuring those new definitions would be used in everyday speech. This is why Al. Javakhishvili is often called the patriarch of Georgian geography. He gathered colleagues and founded Georgian Geographic Society and several geographic faculties in scientific and educational institutes in different cities of Georgia.

The article examines different variations of Georgian geographic terms by Al. Javakhishvili, which were stated in the first Georgian Monography and also the transformations that happened to those terms over the centuries.
Tropical Nights

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Based on the materials of observation of meteorological stations of Georgia for the period between 1936-2013, research has been made of geography, structure, intensity, duration and dynamics of tropical nights on the Georgian territory. The geo-informational map has been compiled, embracing the number of tropical nights for the basic period in accordance with the World Meteorological Organization.

References
Related conflicts and their solutions of the Samtskhe-Javakheti vegetation associations and wildlife biodiversity

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In Samtskhe-Javakheti region Biodiversity-related conflicts has the natural, anthropogenic or legal nature. From them noticeable impact on the living world and the physical degradation is observed. Environmental conflicts is notable black coniferous disease from the wreckers. Black coniferous natural ecological situation is a primary means protection. Samtskhe river dzindzes valleys unique flora uncovered huge damage to the natural-extream processes. It needs the effective measure of protection. Relict forest of Kartsakhi subalpine areas develops in extreme environment. It has the largest conservation meaning in the Javakheti region. Javakheti Lakes extreme climatic conditions, often prevents migrating birds for feed production.

Anthropogenic conflicts remarkable pine forests used to reduce the Javakheti plateau. Kartsakhi relict stands on the lake in the vicinity of a certain impact, dzindzes ganamarkhebuliploris rob a man-made valley. Mountain meadows over pasture degrade it.

Legal conflicts in the region is linked to environmental legislation in full or in part, ignored. They were largely unable to regulate the protection of the plant and animal organisms.
The critical state of the landscape as a pretext to isolation territories under the category of "protected landscape"

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Protected areas are a prominent place in the landscape of the territorial organization and planning. Particular importance is attached Landscape protection. In Region the research process Various expeditions studies described in been about 300 experimental plots, which are located in the region virtually all genus and in the face of the landscape. Central part of Small Caucasus and surrounding areas has been created for the 29 river basin geographic information systems. For each river basin has been created GIS Data Bank, which contains: polygon name and number of the genus and the face of landscapes, rivers and their tributaries names, natural territorial complexes the vertical structure index, natural territorial complexes index, index soil-surface formation, the degree of anthropogenic change, etc. All the above mentioned has enabled us to carry out the study area landscape diversity analysis and draft a series of thematic maps. The research it is particularly interesting landscapes "density" determination. As well as landscape diversity analysis was conducted 10- minute grid the degree (18-11 km) according. Complex approaches and GIS analysis on the base of proposed to 2 polygon, "Protected Landscape "status confirmation of this. Territories, which are proposed to be given a "Protected Landscape " status, has been given a detailed physical-geographical characteristics and was given analysis landscape of their. A detailed analysis of the landscaped of the central part of Small Caucasus and adjacent territories made it possible to identify the unique landscapes the limits of on its location. Conventionally, these areas are referred to Dzama and Bevreti polygons. The main reason for the recommendation Dzama polygon under protected landscapes is what this is the most eastern outpost of Mid-mountain Colchis forest landscapes in the Small Caucasus. Nowhere in Eastern Georgia Colchis landscapes do not go as far as the river basin. Zama. On Dzama polygon present typical colchis landscapes with an undergrowth of rhododendron and laurel. The surrounding area is Bereti eastern outpost of middle mountain-forest landscapes with beech-dark coniferous forests. Bevreti east, not only these landscapes, but also individual trees of spruce and fir are found nowhere else, not only in the Caucasus but throughout the Alpine-Himalayas belt. Next plot with mountain-forest dark coniferous landscapes can be found only in the 2500-3000 km to the east, in the Tien Shan and the North-Western Himalayas (Atlas. Nature and the Earth's resources. V.2, 1998). In this area, the beautiful well-preserved mountain forest landscape with fir forest. Accepted while working on the theoretical and methodological results can be used to perspective a new direction - "Conservation Geography" processing.

References


Dedoplistskaros munitsipaliteti, seasonal sheep-rearing, the water supply problem and its geographic analysis

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The work deals with Georgia, one of the oldest agricultural sector - sheep and cattle partly livestock development problems faced by their resolution and spatial analysis. In the region, district municipality area, where the activity traditional fields and a number of problems facing, it is in turn connected to local geographic and socio-economic situation in the cause-and-effect reflected in the sector's current state and local landscape load, they transform and future trends what is more important in the current climate variability in the background, as each change requires a readiness for new challenges, so it was thought to be a resource and development strategy and sustainable development principles. The study region is a zone of traditional livestock and sheep, especially important for the development of livestock farming is seasonal and there are plenty of ancient traditional and general seasonal sheep, livestock, due to the local climate and landscape features. The study evaluates the current situation of seasonal cattle camps and the deployment of their water supply, the existing problems and their solutions, the region was thematic map, which illustrates the problem. The work also has the sustainable nature of the recommendations.
The Modern Tendencies of Fertility in Tbilisi – Rustavi Agglomeration

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Tbilisi – Rustavi agglomeration mainly is spreading along the river Mtkvari, is located at the spot where several historical and ethnographic regions meet. Agglomeration’s role in the entire system of Georgian settlement is mainly based on its location on the cross-point of the basic country settlement axis, as well as the regional and transnational one.

Tbilisi-Rustavi agglomeration consists of four municipal territories and cities (Tbilisi, Rustavi, Mtskheta, Gardabani).

The crude birth rate for abovementioned cities has been declining rapidly since the 1990’s. By 1995 in the capital crude birth rate dropped to historically low levels (10.3‰).

It should be noted that the absolute number of newborns in 1990-2014 fell by 11.2 percent in Tbilisi. The same phenomenon in Rustavi reached more larger scale (30.3 percent).

In 2014 a higher crude birth rate in Rustavi was determined by the fact that in the analyzed period

(1990-2015) the population of Tbilisi and Rustavi has decreased by 12.9 and 22.6 percent respectively. In calculating the coefficients, this fact makes some changes.

At the beginning of the 1990s crude birth rates in Gardabani and Mtskheta provides extended reproduction of population. Worsening socio-economic conditions in 1990’s were reflected in the processes of fertility of these two cities.


In the mentioned period, calculated by authors - on the basis of the official data - the crude birth rates looks unreal in the analyzed cities. For example, in Mtskheta the marked rate in 1995 made up 53.3‰ and 70.1‰ in Gardabani (2004). That is clearly far from reality. The reason of this fact can be explained by incomplete statistical account of demographic phenomenon.

Using the method of interpolation by the authors was estimated fertility rates, which are more realistically characterize the situation.

In recent years, in Gardabani and Mtskheta observed the process of increasing and decreasing of birth rates. According to the latest data (2014), the coefficients in Gardabani and Mtskheta made up 15.2 and 13.4% respectively, which were lower than coefficients fixed in Tbilisi and Rustavi.

Prepared in the framework of Shota Rustaveli National Science Foundation project # FR /142/ 9 – 280 /13
Investigation of Mountain Reservoirs’ Sedimentation with the Natural Experiments

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Sedimentation process of reservoirs starts with the rivers' blocking and continues as long as the river on the surface of reservoir accumulated sediments, i.e. silting prisms (SP), forms the equilibrium hydrographic curve (EHC). This process is faster in the mountain reservoirs by which the river is able to transport a full range of sediment to downstream. There is no certified method of SP and EHC parameters forecasting up to nowadays; the risks caused by high floods are ignored. The systematic collection of information on the reservoirs is too protracted, therefore it was necessary to study it using the natural experiments.

With the purpose of SP formation process studying and EHC forecasting, field situ experiments on the small mountain rivers of Georgia (Rutskali, Ruchu, Vere) have been carried out. The three streams were blocked by dams of a meter height. Instrumental observations over the SP have been conducted by the program corresponding to their hydro regimes. On the River, where the reservoir volume was less than the sediment annual runoff, approximately for a year SP reached its limited size and EHC was formed.

On the other rivers, processes have been evolved with different intensity. A full-scale field study has shown that EHC is formed much higher than channel’ initial position and due to this, while the flood, it creates a significant threat of catastrophic inundation. After the EHC formation, the reservoir completely loses its function and SP’ surface is represented by inclined to dam parabolic, plane, the area of which surpasses of the reservoir mirror at 30%.

In tributaries SP forms the sediment plumes that extended till the boundary of top water level propagation created by the reservoir. Length of plumes (L) is a function of the maximum water flow discharge (Qm), solid runoff (R), bottom sediment diameter (d) and the riverbed stream initial inclination (I): L=f(Qm,R,d,I).

The number of flood risk increases proportionally to the SP growth and of the river bed height. This is explained by the fact that the probability of catastrophic flooding is increased simultaneously with the sediment plume volume increment in the river bed.

In the approximation form the EHC has a parabola shape that is extended from the dam up to the point of the river bed cross section, above of which it retains the natural transport mode of solid flow during the reservoir operation.

References:
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Characteristics, distribution area and use potential of soils of the highlands of the Caucasus in Georgia

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In the Caucasus region, after 20 years of independence, Georgia still faces difficult social, economic and ecologic problems. The agricultural sector loses its economic importance in the country more and more and the poverty is growing in the regions every day. Within the interdisciplinary project “Scenario development for sustainable land use in the Greater Caucasus, Georgia”, using the example of the mountainous region, the soil characteristics, distribution area, potential of use and capability have been studied in the surrounding territory of Kazbegi (>1,750 m ü. NN). In 2014 and 2015, within two filed campaigns, the soil was mapped and tested in the territory under study. As a result of growing parent materials on the small area and the relief characteristic for the high-mountain area the region is characteristic for the variety of diverse shapes. Soils typical for talus fan of shale of Jurassic period is comparatively depleted, skeleton rich rego soils, which, as a rule, are used as pastures, in certain cases for growing of potatoes and vegetables. On hard rocks the rankers have originated with time, which are used as pastures even at high altitudes. Contrary to that on the Quaternary Pyroklastika (tephra) deep-laying brown earths have been formed, which in the past were partially used as agricultural land, and currently their biggest part is uncultivated, or is used as pasture. Brown earths formed on the glacial sedimentary rocks are used in the same way, which, due to comparatively thinly formed drift, display significantly less soil depth. Calcareous and Vega, as well as gleys and fens abundant in floodplain are used as pastures only. The latter is also abundant on slopes on comparatively small territories, on unconfined coombs of moraines.

Soil use potential is assessed based on SQR and according to physiochemical characteristics of soil.
Estimation of Agroecological Indexes of Kvemo Kartli Region

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Growth, development and productivity of crops in Kvemo Kartli region are mainly provided by agroclimatic conditions. Sum of active temperature (≥10°C) in the region fluctuates within the range of 1900-4160°C according to the districts.

As a result of uneven distribution of atmospheric precipitation during the vegetation period, provision of the soil humidity in the region is not uniform at different phases of crops’ development. in such conditions crops undergo water deficit, which affects the yield (during the vegetation period atmospheric precipitation does not exceed 700 mm). Temperature is one of the factors essential for growth, development and productivity of crops. Generally the presented indexes are satisfactory for the production of most crops. On the basis of the agroclimatic indexes 5 zones are denoted.

Zone I covers eastern and south-western parts of the territory of Gardabani district. Sum of active temperatures (≥10°C) in the zone exceeds 4000°C. According to many years observations annual atmospheric precipitation made 400-500 mm and 300-350 mm during the warm period. It seems to be prospective to grow Fruit crops, cereals, vegetables, oil-seed, technical and other crops.

Zone II embraces the territories of Marneuli, Bolnisi and Tetritskaro districts and spreads to the north of Gardabani district up to Mtshketa districts and to the north-east up to Sagarejo district. Sum of active temperatures (≥10°C) in the zone exceeds 3000°C. Atmospheric precipitation makes 500-600 mm, in warm period – 300-400 mm. All grapevine varieties, fruit-crops, cereals and vegetables can be successfully cultivated here.

Zone III embraces from south-west part territory of Bolnisi district, from the north-Tetritskaro and Gardabani districts and from the north-west the territory of Dmanisi district. Sum of active temperatures (≥10°C) in the zone makes ≥2000°C. Annual Atmospheric precipitation makes 600-700 mm and 600 mm during the warm period. The given zone suitable for cultivation of cereals, vegetables and some fruit- crops and for using as pastures.

Zone IV embraces south-west and north-east parts of Dmanisi and Tsalka districts and insignificant part of north-east parts of the territory of Gardabani district. Total air temperature (≥10°C) in zone is low (somehow higher than 1000°C). Annual Atmospheric precipitation makes 700-800 mm and 550-560 mm during the warm period. The zone is prospective from the viewpoint of pastures and grasslands.

Zone V covers western part of Dmanisi district and north-west part of Tsalka district. Total air temperature (≥10°C) is low (1000°C). Annual Atmospheric precipitation makes 800-850 mm. Root forage vegetables can be cultivated here and pastures and grasslands should be developed.
Assessment of risks of washout of separate sections of riverbanks and other related risks of various level

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Flooding and mudflows in most cases are characterized by suddenness, and due to this fact during their rapid development becomes impossible to carry out corresponding measurement works in time. Besides they are distinguished by wide range of phenomena to be investigated (seasonal observations – once a year, while in case of catastrophic phenomena – once in the decade). When analyzing and assessing the washouts of separate sections of riverbanks and related risks of various level it is important to use the theory of probability, that is complicated due to lack of statistical data and, as a result, because of inadequacy of corresponding probability model to actual processes. Proceeding from the abovementioned significantly increases the role of assessment of parameters of investigated random processes, conducted by the methods, which take into account the limitation of initial statistical data. Along with point estimation of unknown parameters (assessment in one number) these methods allow us to determine what is the probability (confidence probability) of occurrence of one or another characteristic parameter of random process within the limits of some range of values (confidence interval). Solution of this problem for washout of separate sections of riverbanks is given in the presented work.

The probable values of maximum discharges have been determined (specified) for separate sections of Georgian rivers. For identification of related risks we have turned our attention to the so-called flood activity coefficient. Determination of flood activity coefficient and solution of virtual examples (cases) gave us an opportunity to identify river sections, which are the carriers of relatively high risk.
PERSEUS aTools - AMP Toolbox for designing and implementing adaptive policies in the Eastern Black Sea

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The article deals with the problem of application of PERSEUS Adaptive Marine Policy Toolbox (AMP Toolbox) in small non-EU countries. The short empirical analysis deals with the case of Georgia based on the experience gained by Tbilisi State University through activities associated with both SESAME and PERSEUS EU funded projects. Results of such analysis lead to conclusion that the actual application of AMP Toolbox might be rather restricted, based on absence of GES oriented goals and priorities in the country as well as restricted representation of local stakeholders in decision making in marine environment, all related programs/projects (with few exclusions) primarily originating, financed and managed externally.
Some issues of calculation of minimum runoffs and sanitary-ecological discharge of small mountain rivers

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Most part of Georgian rivers is represented by mountain rivers, for which high specific energy potential is characteristic that draws permanent interests of investors. In this regard are especially noteworthy small rivers, for which the large-scale assessment of regime elements of runoffs is of great importance. Minimum runoffs is one of the key issued of hydrological calculations, since minimum discharges of water course determine not only sizes of projected enterprises and population centers, but also the opportunity of their disposition at this place. At the same time is necessary to determine sanitary-ecological discharge, i.e. amount of water, which has to run permanently through riverbed in order to preserve its transportation capacity and river ecological system, in general.

Initial data of minimum runoffs at small mountain rivers don’t exist in some cases or they are not correct. Also there are no normative standards, determining the calculation rule of sanitary-ecological discharge. During designing of hydrotechnical facilities is used the common practice, which takes into account keeping (preservation) of some part of minimum runoffs or average multiyear discharges in the riverbed. With that during last years, due to climate changes river runoffs have different response that is reflected in obvious variability of peaks of maximum and minimum levels and water discharge according to seasons.

Establishment of precise chronological changes of runoffs’ determining factors and forecasting their virtual changes for long-term period is very difficult task and we have to proceed to calculations of minimum runoffs and sanitary-ecological discharge of small mountain rivers with utmost care in order to prevent irreversible negative effect on environment caused by operation of hydrotechnical facilities.
The impact of climate change on the temperatural dynamics of Samtskhe-Javakheti region

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The interdependence of climate and humans is the most important problem at the present stage of human development and it could become a cause of social progress or degradation in the future. This circumstance is especially noticeable in mountainous countries such as Georgia. In this respect, particularly stands out Samtskhe-Javakheti, one of the most important regions in Georgia. Samtskhe-Javakheti is located in the southern part of the country and by the climatic conditions is in sharp contrast to other regions. This can be explained by the influence of the local factors. Temperatural dynamic of Samtskhe-Javakheti, as its climatic conditions, is distinctive by various characteristics, which are mainly related to the location, difficult terrain of the territory, radiational regime and general and local circular conditions of the Atmosphere, which are prevailing in this region. To assess the climate change in Samtskhe-Javakheti, the data from 30-40 year observation period was used from the following meteorological stations: Akhalqalaki, Akhaltsikhe, Bakuriani, Tsalka, Paravani, Goderdzi mountain pass, Borjomi. We have carried out the temperatural data analysis for the 10-year observation periods for all listed meteorological stations. As a result, the following changes of the average temperature was found according to the different year periods: In Akhalqalaki, during 1967-2006 years, (I-IV) periods, the average temperature was increased by 0.73°C/40y, in Akhaltsikhe, during 1967-2006 years, (I-IV) periods, the average temperature was increased by 1.00°C/40y, in Bakuriani, during 1962-1991 years, (I-III) periods, the average temperature was slightly changed and decreased by 0.09°C/30y, in Tsalka, during 1967-2006 years, (I-IV) periods, the average temperature was increased by 0.70°C/40y, in Paravani, during 1967-2006 years, (I-IV) periods, the average temperature was increased by 1.13°C/40y, on Goderdzi mountain pass, during 1963-1992 years, (I-III) periods, the average temperature was decreased by 0.73°C/40y, in Borjomi, during 1962-2004 years, (I-IV) periods, the average temperature was increased by 0.37°C/40y. The research results of Samtskhe-Javakheti meteorological observations, enables us to conclude, that, in the background of climate change, the sharp changes of average temperatures have been occurred in this region. There are also clear cases of varying warming/cooling patterns.
Flood and flashflood frequencies estimate on the river Adjaristskali

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Floods and flashfloods are distinguished by their frequency and loss of natural disasters. The world's natural disasters are linked to floods and inundations of which are the most frequent natural disasters in comparison to other, climate change is expected to increase in the frequency and intensity of natural disasters increase, as observed in recent years.

Impact of floods and flashfloods devices in two different types:
- Damage and destruction of different types of engineering structures (for example, dam, bridge, bank protection structures, etc.);
- The river shore and ran groves, settlements and agricultural lands flooded.

Flood and Flash Flood risk refers to the probability of their occurrence and impact (losses, opposite) natural and agricultural facilities, the risk of exposure to risk. The risk can be measured frequency likelihood methods, and the exposure to risk - in injury and negative. The frequency of the observed values of the past, the likelihood - the possibility in the future. The frequency is the result of what has happened, while the probability of a prediction of what should happen. The above mentioned study and analysis was carried out on example on the river Adjaristskali.
Risk Mapping and Preventive Measures Development in Pankisi gorge

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Among the most dangerous natural disasters (12) in Georgia, floods have the leading role and are followed by huge material damage and losses. In August, 2010, during the visit of UN representatives to Pankisi gorge, the necessity of identification of flood-prone ravines/zones and development of risk maps had been emphasized and put on the agenda. Regarding this issue, on the basis of the contract concluded with UNDP, conducted flood risk assessment in specific ravines of river Alazani basin (Pankisi gorge) and developed relevant preventive recommendations. As a result, the data required for creation of early warning system in the indicated area have been collected giving opportunity of introduction of risk management preventive approach in the region.

The aim of the project was to assess the flood-prone villages (Dzibakhevi, Birkiani, Jokolo, Duisi) located on both sides of Alazani channel (9.5 km length section) in Akhmeta district Municipality, identify the most vulnerable population and develop adequate preventive measures. The mentioned above villages were selected for research due to the flash flow that took place on June 17, 2010 and was followed by damage (residential houses, agricultural lands, pastures damaged, domestic animals loose). The damage cost exceeded USD one million. Hydrometeorological station in the gorge ceased functioning long time ago.

On the basis of the meteorological (temperature regime, winds, precipitations, etc.), hydrological (hydro-network, ravine morphometry, hydraulic characteristics, calculation of different probability water discharge cross-section profiles of ravines), cartographic (site planning and placement on map) researches, engineering measures to be conducted as well as the population’s at risk disaster risk reduction recommendations (recording of population number, age, gender groups, assessment of social-economic conditions, calculation of inflicted damage) have been elaborated. Modelling of different probability water maximal discharges has been made on the district relief digital model created via geo-information technology, possible catastrophic flood-risk zones have been allocated, risk maps developed.
Population’s Attitude Towards Ecological Problems (Case Study of Mestia Municipality)

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The goal of our research is the study/displaying of population’s attitude in one of the mountain regions of Georgia – Mestia municipality, towards ecological problems in the context of regional development.

Mestia municipality is one of the largest municipalities of Georgia, population of which is relatively small taking into account its area. Rapid development of region and expansion of corresponding infrastructure takes place here from touristic viewpoint.

Questionnaire survey was conducted among Mestia municipality population. SPSS package was used for statistical analysis of results of polling.

The most important ecological problems of Mestia municipality population were identified as a result of the research.

Obtained results are very important for elaboration of strategy of sustainable development of region, and are also quite interesting on a global scale as spectacular example of mutual relationship of environment and mountain regions’ population.

References
The research-popularization of endogenous origin nature monuments in Rioni river basin

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Georgia is a country of geomorphological contrasts. A wide variety of hypsometric and morphological terrain forms: deep canyons, subterranean labyrinths, flat plains, different altitude plateaus, high mountains, ranges are present on its surface. In this regard, Rioni basin is a very interesting region.

Natural monuments are unique, being represented by only a few exemplars. They are often being damaged, sometimes completely destroyed. Because of all this, rare and unique creatures of the nature are lost, without any possibility of restoration. We need to develop an integrated programme for their conservation, protection and usage. The basic purpose of this research is to study natural monuments and ensure their popularization. Study of natural monuments with the aim of their popularization is an important issue in our country. This basin is so rich with different endogenous forms that there is a possibility to discover/study new objects which are known for the locals only.

Some of the remarkable monuments are the objects of local or international importance, but they sometimes lose their natural beauty as a result of human intervention. Therefore, it is necessary that natural phenomena of such importance have a status of natural monument.

Many natural monuments in Georgia have been damaged or completely destroyed over the last years. Natural monuments need to be registered and protected, so as to maintain natural phenomena. Numbers of unique natural monuments are not well-arranged and protected. If they are promoted properly, nature objects can be included in tourist and excursion routes.
Section 4 - Department of Electric and Electronic Engineering

- Electromagnetic Compatibility
- Antennas and Wave Interference (Wave Propagation)
Modeling of 3D Optical Antenna Using Method of Auxiliary Sources

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Research paper presents investigation of optical nanostructures. Optical antennas are very attractive for modern devices that are expected to have a strong impact on future developments in the area of high density integration, communication technology, and biomedical equipment.

It is demonstrated that difficult numerical problems are caused because optical antennas exhibit strong material dispersion, loss, and plasmon-polariton effects that require a very accurate numerical simulation (Figure 1, Figure 2).

REFERENCES

Radiation Power of Time Harmonic Oscillating Electric and Magnetic Diploes System

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In the applied electrodynamics, antenna, diffraction problems are often solved by numerical methods, which are based on the integral representation. Solutions are represented in the problem by electrical, magnetic or combined current distributions. Often from a solution to a problem it is needed to estimate radiation power, to assess the work of external forces, energy balance, effective cross section, and so on [1, 2]. It is linked to at least triple integration. Double integration relates to $4\pi$ spatial angle, and other to the area of current distributions. From point of view of generality and simplicity the work deals with system of a finite number electric and magnetic dipoles arbitrary distributed in space. Each dipole oscillates with arbitrary amplitude radiates time harmonic electromagnetic wave. The time factor system is $e^{-\omega t}$. The goal is to define the total energy flow, which is the system radiates to infinity, the energy flow is considered on S surface of sphere with infinite radius.

References
SAR and Temperature rise during magnetic nanoparticle hyperthermia therapy

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1. Introduction. Recently, nano-particles (NP) hyperthermia emerged as one of most promising technologies \cite{1, 2} for treatment of cancers at cell level. Studies show that cancer cells accept and accumulate NP more preferable than normal cells \cite{3}.

The mechanism of nano-scale hyperthermia and temperature distribution at cell level is not clear and needs numerical and experimental studies to further optimizing NP hyperthermia for treatment of all kind tumor cells.

We use Bio-Heat equation with Fourier and Cattaneo Equation Models. Bio-heat with the Fourier

\begin{equation}
\rho C_\text{p} \frac{\partial T}{\partial t} = - \nabla \cdot \overrightarrow{q} + \rho \cdot \text{SAR} + A_0 - B \cdot (T - T_b)
\end{equation}

heat flow model is: We have energy conversation equation

And lagged equation for flux proposed by Tzou \cite{4}

\begin{equation}
\overrightarrow{q} + \tau_q \frac{\partial \overrightarrow{q}}{\partial t} = \overrightarrow{g} + \tau_T \frac{\partial \overrightarrow{g}}{\partial t}
\end{equation}

Where

\begin{equation}
\overrightarrow{g} = -k \nabla T
\end{equation}

In Cattaneo \cite{6} equation case when there is no gradient lagging $\overrightarrow{F}$ is just $\overrightarrow{g}$. In classical case (Fourier's low) $\overrightarrow{q}$ is just $\overrightarrow{g}$. We can use different boundary conditions for volume control cell assuming conditions for $T$, $\overrightarrow{q}$ and $\overrightarrow{g}$ and call it nano-scale Cattaneo bio heat equation. For modeling Bio-Heat equation we use Finite Difference Time Domain Method \cite{5}. We choose computation grid is similar to FDTD grid. In space in the centers of faces we have heat flux components and in center of computation cell we have $T$.

2. Phantom experiment.

Two homogeneous cylindrical phantoms, one with an embedded torus section shaped spacer, the other with no spacer acting as a control phantom were individually positioned on the treatment table, centered over the induction coil. The phantoms had equal conductivity of 0.6 $\Omega^{-1}\cdot m^{-1}$, and each was exposed to an AMF for 30 minutes at 16.25kW nominal power. The phantoms were left stationary for

![Fig. 1: (a) bottom half of control phantom. (b) bottom half of displaced phantom. Temperature distributions at 1900s for (c) control and (d) displaced phantoms. The color axis ranges from 14.6-71.6°C.](image-url)
the entirety of the exposure, after which they were cut along the vertical axis of symmetry to expose the internal cross section to measurement by IR thermometry.

3. SAR and temperature rise calculation.

Experimental results are given on Fig.1. Calculated $T$ is known at half time steps and flux is known at integer time steps. Using well known leap-frog discretization scheme [5] for cattaneo BHE and obtain update formulas (4), (5) and (6). For testing we investigated Cattaneo BHE 1D model with following setup: Space discretization $dx = 10^{-8} \text{m}$, number of cells $N = 400$, for material we have taken Brest material [7]: $r = 1058 \text{kg/m}^3$, $k = 0.5 \text{J/(s} \cdot \text{C)}$, $M = 758 \text{J/(s} \cdot \text{m}^3)$, $B = 3346(\text{J/s} \cdot \text{Cm})$, $T_b = 37.2^\circ \text{C}$. For simplicity we have set $T = 37.2^\circ \text{C}$ constant boundary condition. In first Steady state distribution was evaluated. When SAR was set in range of cells [100:150] to $10^{4}$ and temperature rise is evaluated. Several values of $\tau$ were reported [8] For parameter $\tau = 5 \cdot 10^{-3} \text{s}, 5 \cdot 10^{-2} \text{s}, 1\text{s}$ and $5\text{s}$ values were chosen and simulation time step $\Delta t = 10^{-5} \text{s}$, $\tau = 0$ represents Fourier model. Leap-Frog discretization of BHE for Cattaneo model gives:

\[
T_{t+1/2}^{n+1/2} = T_{t+1/2}^{n+1/2} + \frac{\Delta t}{c_{\alpha, j, k} P_{\alpha, j, k}} \left( \sum_{\alpha=1}^{3} \Delta q_{\alpha, j, k} / \Delta x_{t+1/2, j, k} + P_{\alpha, j, k} S_{t+1/2, j, k} + A + B (T_{b} - T_{t+1, j, k}) \right)
\] (4)

\[
g_{t+1/2, j+1/2}^{n+1/2} = \frac{2k_{t+1/2, j+1/2} S_{t+1/2, j+1/2} + T_{t+1/2, j+1/2} - T_{t+1/2, j+1/2}}{\Delta x}
\] (5)

\[
\tau_{t+1/2, j+1/2}^{n+1/2} = (0.5 + \tau_e / \Delta t)^{-1} \left( \sum_{\alpha=1}^{3} \tau_{t+1/2, j+1/2, k+1/2}^{n+1/2} + \frac{\tau_{t+1/2, j+1/2, k+1/2}^{n+1/2}}{\tau_e / \Delta t + 0.5} \right)
\] (6)

![Fig. 2: SAR (W/kg) and Temperature(C) rise distributions at different time](image)

Fig. 2: SAR (W/kg) and Temperature(C) rise distributions at different time.

We see on Fig.3 difference classical Fourier and Cattaneo models. Namely, local heat accumulation and temperature rise effect for $\tau > 0$. For a large $\tau$ and small exposure times much less then $\tau$ difference between

![Fig. 3: Cattaneo equation for different $\tau$. T rise and Heat flux for different $\tau$](image)

Fig. 3: Cattaneo equation for different $\tau$. T rise and Heat flux for different $\tau$. 

\[105\]
Fourier and Cattaneo models are significant.

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Improving of Photocatalytic TiO$_2$ Nanopowders Efficiency and Their Potential Applications

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Currently the consumption of gas and fuel resources on the Earth will be soon exhausted. It is not possible to slow down this process, the only way out is finding of the alternative energy sources: the most perspective direction on this way is water dissociation into hydrogen and oxygen using solar energy and utilization of produced hydrogen as fuel, the final product of which under burning is again water. Nowadays a topical problem is the increase of efficiency of the photocatalytic reaction. By this we mean the dissociation of water into hydrogen and oxygen by using the solar ray energy and photocatalysts. Photocatalysis is initiated by the absorption of photon by semiconductor oxide TiO2. The resulting energy is equal to or greater than the band gap of the semiconductor (3.2 eV for TiO2), which produces electron – hole pairs. The low-temperature chemical method to coat powders by different sized material nanoclusters (magnetic metals and silver) was developed by our group. The peculiarity of the method is in the maintaining of low temperature during the deposition reaction (58–60°C). The novelty of our work is in the investigation of optical properties of TiO2 powders coated with Ni-B and Ag nanoclusters by the above-mentioned unique method and improvement of their photocatalytic properties by increasing visible light share in the photocatalytic process, what improves the photocatalysis reaction efficiency. We suggest methods for the improvement of optical properties of TiO2 nanopowders: our original methods of cluster coating, vacuum treatment, choosing of optimal sizes, to apply to TiO2 nanotubes and study the possible increase of the absorption of visual part of solar radiation by these objects (fig1).

Figure 1. The absorption spectra before the heat vacuum treatment and after it for TiO2 (anatase) coated with Ni-B clusters.
References


Engineering Problems and Tasks in Earthquake Prediction Problem

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This presentation is focused on two problems of earthquake prediction that need engineering support and creation of specific observational and laboratory experimental equipment. The first problem is to find the answer on the question of principal predictability of earthquake as an event classified as selforganized criticality phenomenon. Gutenberg-Richter law of earthquake power – repeatability frequency flicker-noise like dependence constrains predictability in principle. But statistical investigation of earthquakes repeatability reveals synchronization phenomenon caused by tidal parametric modulation of the ultimate stress of Earth’s crust structures (Lursmanashvili O., et al., 2010). We have studied this phenomenon in specially created laboratory installation generating self organized criticality of sand avalanches in rotating tube, and modulating the criticality limit reach time by the modulation of rotation frequency. This laboratory experiment distinctly demonstrates parametric modulation simultaneously demonstrating flicker-noise dependence as integral characteristic of process.

The second engineering problem we have sold is the construction of Earth’s crust electromagnetic emission monitoring device for the range at the border of very low (VLF) and ultra low (ULF) frequency. Researchers usually avoid the range near 1 kHz due to the electromagnetic radiation caused by the variety of voltage supply converters harmonics. Our observations reveal the significant information capability of this range. Some earthquakes precursor processes were recorded by observations. The state of diurnal variation of emission is the sensitive indicator of preparing quake. Lursmanashvili O., Paatashvili T., Gheonjian L., 2010. Detecting quasi-harmonic factors synchronizing relaxation processes: application to seismology. In “Synchronization and Triggering: from Fracture to Earthquake Processes: Laboratory, Field Analysis and Theories” Ed. By V. de Rubeis, Z. Czechowski, R. Teisseyre. Springer, 2010, pp. 305-322.
Section 5- Department of Geology

➢ Geology
Geo-stratigraphic attitude of basalt lavas revealed in the basin of the r. Stori and new data on the prospectivity of their utilization as face-stone raw material

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The river Stori, a left tributary of the Alazani, forms a deep canyon-like gorge, which cuts and, correspondingly, exposes Jurassic shale series across the entire thickness constructing a southern slope of the Caucasus.

The shale system in this region forms anticline structure shifted to the South, the core of which is composed by Hettangian-Sinemurian-quartz, arkoz, grauvak-arcoz sandstones. In the upper part of the structure is also detected lava sheets of dacite composition with some meters thickness and their tuffs. The complex underwent strong hydrothermal-metasomatic metamorphism and passed into secondary quartzite, quartz-sericite-pyrite and quartz-epidote-chlorine-pyrite shales. This complex is known as “Stori suit” in literature.

As known, by stratigraphic method it was ascertained that first Early Pliensbachian aspide shales and then Late Pliensbachian monotonic shale series pass above both sides of the Stori suit. At the southern side of the anticline structure (we continue its schematic lithostratigraphic characterization) at the boarder of the Late Pliensbachian and Early Toarcian monotonic shales is revealed interesting for us basaltic lava complex. Early Toarcian deep sea shale suit gradually passes into - Late Toarcian and thick-layer arkose and mixed composition sandstone deposits of regressive character. In the South, it is followed by Aalenian and Aalenian-Early Bajocian – Aleuropelite and fine- and middle-grained polymictic deposits bordered with fault by cretaceous-carbonaceous deposits passing into Alazani depression.

In 2014, by financial support of the Ministry of Science and Education of Georgia, the group of our department (professor B.Tutberidze, associated professor K.Akimidze, postgraduates A.Skhiladze, G.Khachapuridze, T.Jgushia) has studied the noted basalt lava complex as possible raw material for face-stone at the right side of the river Stori and in the basin of its right tributary Svanaskhevi. It was found that the lava complex stretching almost 3 km distance is connected with the Upper Pliensbachian-Lower Toarcian age deep fault zone spread throughout the entire Caucasus region. Thickness of the zone exceeds 300 m. 10-45 m thickness stratifications alternate echelon-like, their total thickness is more than 100 m. At the same time, the complex fully satisfies qualified standards of construction and ornamental raw materials.

In 2015, the group with altered staff (associated professor K.Akimidze, postgraduate M.Makadze) continued to study the complex at the left slope of r.Stori and in the basin of the r. Eshmakiskhevi. In spite of the poor exposure (a forest belt) and a complex relief magma containing zone stretched for 1.5 km distance. Thicknesses of lava sheets, lying forms, physical and chemical properties and ornamental parameters in this interval are analogous to characteristics studied earlier. Correspondingly, the supplies of the raw material is increasing almost by 1/3 that will be discussed in detail in the report.
Sedimentological-Ichnological Study of Lower Cretaceous Deposits of the River Pshavis Aragvi Gorge

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During the field work conducted in summer 2015 were carried out integrated sedimentological- ichnological studies of several cross-sections of the Lower Cretaceous deposits which crop out in the river Pshavis Aragvi gorge. On the basis of existed (Varsimashvili E., 2000) and our personal observations data Lower Cretaceous in the study area is represented by incomplete section from Hauterivian to Albian.

The oldest formation here is the lower Hauterivian Bakhani suite constituted by the alternation of calcareous and siliciclastic sediments-limestones, marls, sandstones, argillites (thickness 100-250m.). In the way-up section it is followed by greywacke-aleurolitic Pasanauri suite, this in turns is subdivided into three subsuites. The lower subsuite (100-300m.) is constructed by argillites and quartz-plagioclase sandstones (Upper Hauterivian); the middle subsuite (Lower Barremian) is constituted by quartz-arkoze thick-bedded sandstones with argillite interlayers( 90-250m.) and the upper subsuite(80-130m.) is built up by argillites and quartz-plagioclase sandstones(Upper Barremian).Pasanauri suite grades into the Aptian Tetrakhevi suite represented by alternation of black and grey argillites and quartz-plagioclase-mica bearing sandstones(220-250m.).The Lower Cretaceous section ends by variegated argillites, grey marls and sandy limestones of Pavleuri suite with volcanogenic-sedimentary formations in its upper part (250-300m.).

Above described Lower Cretaceous rock units have all characteristic features of flysch due to their composition and feeding source of material represent the entire flysch formation with clastic-calcareous and graywacke-aleurolitic members.

Clastic-calcareous flysch is developed in the upper parts of the studied complex on the basis of granulometric and compositional features and thickness of rhythm elements is attributed to marly-argillaceous subtype. In the greywacke-aleurolitic subtype are defined sandstone-argillitic (“normal” flysch- Hauterivian), sandstone bearing (Lower Barremian) and argillitic( Upper Barremian-Aptian) varieties.

Different types of erosional structures are observed mainly in Hauterivian and Barremian sediments of the river Pshavis Aragvi basin. Current directions of the developed here erosional scores (flute marks) are mainly N-NW 0°-5° and indicate that source area for sediment transport is the high- relief basin margin (Bathonian cordillera).

In the Lower Cretaceous deposits of the river Pshavis Aragvi gorge have been recognized (preliminary detections) representatives of the following ichnogenus –Chondrites (2 ichnospecies), Cochlichinus (1 ichnospecies), Nereites (1 ichnospecies) and Zoophycos (1 ichnospecies). Presence of meandering and spiral traces in the ichnocomplex is diagnostic of biotype with stable environmental conditions and restricted food resources i.e. deep sea basin floor (Nereites ichnofacies). As for Chondrites, their distribution is diagnostic of low-oxygen environment.
Geological Interpretation of Poladauri Magnetic Anomaly

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From a number of ore occurrence identified on the territory of Georgia one of the significant iron Deposit is on the territory of Poladauri of the Bolnisi district. In the sixties of the last century, the carried-out magnetic survey of this territory showed the insolvency of a magnetic exploration for detection of deposits, as a mineral hematite, which contains 70% of iron, due to its antiferromagnetism creates a magnetic field of low power. Surveys which are carried out by modern equipment gave the possibility to determine the depth and form of a bedding of the bodies causing the magnetic anomalies, which well coordinated with the data which are received from wells drilled on this area.
Volcanogenic-Sedimentary Rock Flora Fossils of the Goderdzi and Post Volcanic Mineralization Process

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Flora fossils preserved in volcanogenic-sedimentary rocks of the Goderdzi suite has attracted attention of researchers for a long time. It is one of the factors determining the age and restoring climatic conditions for containing rocks; Remains of fossil flora placed in tufogenic part of rocks in the form of well preserved different size and morphology leaves, large-size fossilized plants and separate stems. Rich collection of flora gathered by us includes: Myrtus sp, Platanus Aceroides, Corylus insignis Heer, Sapindus capanoides ett, Acer sp, Quercus neriifolia A. Br and etc. Study of morphology of flora imprints was conducted at the Institute of Paleobiology of the National Museum of Georgia. New types of fossil flora has been established as well. Described samples is characterized for subtropical climate conditions and according to some researchers is almost identical to oligocene and low miocene flora of Western Europe. Post volcanic hydrothermal process products were revealed in volcanic-sedimentary Goderdzi suite from which calcite and chalcedony are leading; Field observations may suggest that calcit-calcledon type mineralization process took place at the final stage of formation of pyroclastic part of the Goderdzi suite. Mineral-like paragenetic associations in different sections means the existence of common magmatic sources nourishing them and post volcanic hydrothermal magmatic nature of originating solutions.
The damages rostrum belemnitids of the Early Cretaceous

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Belemnites represent an important group of cephalopods to the stratigraphy of Jurassic and Cretaceous sediments. Their remains in the form of the rostrum, rarely phragmocone characterized by the global spread of the Mesozoic deposits in Europe, Asia, Africa and America.

For the first time on the rostrum of lifetime traumatic injuries belemnite been described and ilustrirovano in 40th years of XIX century.

A study a few tens of Early Cretaceous rostrum, on which are marked traces lifetime of damage. There are the following forms of damage: a) bending of the rostrum; b) rounding the tip of the rostrum; g) bending and deflection apical line; d) breaking off the rostrum; e) damage to the upper layers of the rostrum.

Analysis lifetime damage gives the opportunity to explore some of the issues belemnoidey biology. We have described several cases of complete fracture rostrum early life. All cases of mechanical injury (damage) of the rostrum can be divided into two groups: a) breakdown, which caused damage to the mantle; b) damage without major damage to the mantle.

Phragmokone and rostrum experiencing a lifetime and postmortem damage. At the same time phragmokone fossil is very rare. So rare finds his injuries, but this material suggests that damage phragmokone (especially the initial part) do not affect its viability. Animal continued to exist after the healing of wounds.

Lifetime damage rostrum and phragmokone, as well as an analysis of post-mortem change and strain showed that it is impossible to clearly define the structure of the rostrum in his lifetime. It can be assumed that most of the rostrum belemnoid when life was hard, calcite and only around the alveolus - soft, supple, organogenic. This part the rostrum in different groups belemnites were of different sizes
Evidence of shallow-marine depositional environment of the host rocks of the Madneuli polymetallic deposit, Bolnisi district, Georgia

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The Madneuli copper-gold polymetallic deposit is the major ore deposit of the Georgian Bolnisi mining district in the Artvin-Bolnisi belt in the southeastern part of Georgia, Lesser Caucasus. Numerous ore deposits occur in the Bolnisi region connected with Upper Cretaceous explosive volcanic events. Our study, based on physical volcanology and sedimentary basin analysis is the first detailed approach for the host rocks of the Madneuli deposit, which still need to be carried out in future investigations in similar environments along the Lesser Caucasus and the Eastern Pontides, where the submarine or subaerial depositional environment of rock units is still very much debated or poorly constrained.

The host rocks of the Madneuli deposit consist predominantly of lava, pyroclastic, volcanogenic-sedimentary and sedimentary rocks of rhydacitic composition, which are grouped in two facies assemblages: volcanic and volcano-sedimentary (Popkhadze 2014; Popkhadze et al.2014). The thickness of volcano-sedimentary facies assemblages is about 200m and predominantly occurs in the open pit.

The association in the volcano-sedimentary complex, where bedding textures are consistent with deposition with turbiditic currents, with the presence of slumps, cross-bedding, load casts, groove marks, wave and current ripples, different bioturbations and radiolaria-bearing horizons support a submarine depositional environment for the bedded volcano-sedimentary rocks in the Madneuli open pit. Hyaloclastite records the interaction of magma emplaced in unconsolidated volcano-sedimentary rocks associated with a submarine rhyodacite dome, emplaced during several pulses (e.g. Gibson et al. 1998). The presence of chilled juvenile clasts, the angular, blocky, moderately vesicular volcanic glass shards attest to the sudden chilling, as well as the high confining pressure during themagma-water interaction (Nemeth and Martin 1999) during the phreatomagmatic explosion in the Bolnisi region. This is also documented by the presence of phreatomadmatic breccias in the open pit.
Heat Field of Caucasus

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In the presented work the results of studying of a heat flow distribution and calculations of temperatures of the Crust of the tectonically and seismic active Caucasian region are given. The distribution of a heat flow is made on the basis of the experimental data and also on the basis of the calculated flow values.

Temperature calculation was performed by solving the heat equation. Study region was covered with equal-step grid and in its node bedding depths of boundary surfaces are known. The temperature calculations were performed at the nodes of the lattice at the bottom of the sedimentary complex, and at the border of Conrad and Moho. The calculations take into account the dependence of the coefficient of thermal conductivity of rocks on temperature.
Javakheti volcanic highland neotectonics

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Our study object is located of southern slope of Javakheti Ridge and is represent by intensive deformed volcanic rocks. They are the analogues of the Upper Miocene-Lower Pliocene Goderdzi suite. Folding of these lavas is indicative of the tectonic activity of the region at the Late Neogene stage of its development. Especially, “Kamarlo” lavas are intensively folded in contact with Middle Eocene rocks. The folds are of fault-related type. The contact is tectonic and it verifies to the activity of the Dmanisi fault. The version that folding of these lavas is flow-induced has been rejected. Seismological and seismotectonic investigations show that the Javakheti and Dmanisi faults belong to the sub-vertical right -lateral strike-slip faults. Investigations of distribution of depth by magnitude (M≥4) have shown that earthquake depths mostly change from 8 to 15 km. The orientations of maximum horizontal stress are North-South that reflects the orientation of acting regional compression.
Peculiarities of Copper-pyrrhotite and pyrite-polymetallic ore formation of the transalazanian Kakheti area on the example of Satskhvrexorxi ore occurrence

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Transalazanian Kakheti area as a prospective region of copper-polymetallic mineralization, is interested for geologists from the 70-ies of the 19th century. The practical interest of this object has particularly increased since 60-ies, when on the eastern extension of transalazanian kakheti (the territory of Azerbaijan), in the similar geological conditions of our study area has found katsdaghi, pilizchai and katekhi large sulfid copper- polymetallic deposits.

Among the many ore occurrence in this region, one of the important is satskhvrekhorkhi occurrence, which is located in the north slope of the Stori - lopota (transalazanian) anticlinorium, along Arshi (sublatitudinal) regional fault crossing with Stori-satskhrehkorkhi transverse (submeridian) deep fault.

During the fieldwork in this ore occurrence we revealed 3 subzone of copper-polymetallic mineralization with thickness from 1.2 to 7.5 meters. This subzones are represented with quartz-sulfide subparallel veins, their capacities variates from 1 to 50 cm. Ores are characterized by massive, brecciated and veinless-impregnated textures. According to their mineral composition: pyrite-polymetallic, pyrite-chalcopyrite and pyrite-polymetallic mineralization is revealed. According to the Structural Interdependence of the different compositional veins, we can describe their gradual formation. The work also includes the study of the gold mineralization of this ore occurrence.
The upper cretaceous volcanic of river Tedzami valley agate-chalcedony mineralization

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The study region is situated from Tbilisi to the north-west about 80 km and administratively belongs to the Caspian municipality.

According by E. Gamkrelidze's tectonic zoning of the territory of Georgia of the latest scheme (2000), the district is located in the East part of central subzone(axial) of Ajara - Trialeti fold zone and it is built Cretaceous and Tertiary deposits. Lower Cretaceous represented only with albian floor, which composed: tuffbreccias, tuffconglomerates, tuffsandstones and there are in sequence porphyrites of augite and augite- labradorite.

Upper Cretaceous is represented igneous and carbonate facies. Volcanic formations are built: basaltic and dacitic tuffs, tuff-breccias, they are in sequence with lava layers, their total capacity varies several hundred meters to 2000 meters.

Based on field observation shows, that processes of mineralization of agate and chalcedony are controlled by two main factors in the study area:

1. Tectonic - mineralization of agate and chalcedony is associated with interrupted dislocations.

2. Lithological - deposit of agate and chalcedony is localized in rocks (tuffbreccias, tuffsandstones, lava layers and Breccia zones in rocks), whose physical properties and textural particularities are favorable for the formation of these minerals.

In the work is discussed the problem of the origin of the agate-chalcedony and their accompanying minerals and role of cretaceous effusions in the formation of deposit.

Construction of Geomagnetic Secular Variation Curve (SVC) for the Territory of Georgia

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Archaeometric dating techniques are nowadays commonly applied as routine tools in archaeological studies. Quite a number of techniques are available and the choice of the most suitable
depends on several factors, as the typology of materials studied, their preservation, their absolute chronology and finally the accuracy of the method.

During the last decades, archaeomagnetism has established great progress in reconstructing chronologies of baked sediments, archaeological features and volcanic rocks. The ability to yield absolute ages mainly depends on our knowledge about the past secular variation of the Earth's magnetic field for a given territory, and so on the existence of well-detailed and reliable reference curves. To construct such a curve for the Caucasus and particularly for Georgia is necessary accurately dated archaeomagnetic studies which have been carried out on well-dated and undisturbed since firing archaeological structures and volcanic deposits.
Section 6- Department of Chemistry

- General, Inorganic and Methalorganic Chemistry
- Organic chemistry
- Bio-organic chemistry
- Chemistry of Macromolecules
- Physical and Analytical Chemistry
Synthesis of 2,9-dioxo-hexamethyldindolino[4,5-e]indolinel

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In order to obtain dinitrozo compound [1] we carried out the reaction of Fisher base analogue - hexamethyldimethylenindolino[4,5-e]indolinel [2] with nitrous acid (solution of sodium nitrite in acetic acid). The reaction undergoes in two steps. At first step respective dioxime as salt of perchloric acid-diperclourate was separated. The alcoholic solution of obtained salt was processed with solution of sodium hydroxide , afterwards instead of expected dinitroso compounds was formed symmetric 1,1,3,8,10,10-hexamethyl-2,9-dioxoindolino[4,5-e]indolinel. In other words unlike of indole in case of indoloindole, with adding strong base, from perchlorate of dioxime with perchloric acid molecule of HCN is eliminated which leads to formation of symmetric 2,9-dioxo-indoloindole. Synthesized new structures is proofed with data obtained from IR, UV, ¹H-NMR, ¹³C- NMR and mass spectra.
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Our studies about chirality, chiral recognition mechanisms and enantioseparations in 2015

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In this presentation those of our current studies are discussed which were either published or accepted for publication in 2015 in the international journals with impact factor. These studies basically relate to chirality, chiral recognition mechanisms and separation of enantiomers by using various methods. In the first group of our studies the separation of enantiomers of chiral compounds representing various structural and pharmacological groups were studied by using high-performance liquid chromatography (HPLC) and polysaccharide-based chiral columns. In these studies especial attention was paid to the elution order of enantiomers [2, 3, 6]. Two published papers are devoted to separation of enantiomers in capillary electrophoresis [1] and capillary electrochromatography [8]. Another two papers were published about the preparation of a synthetic analogue of natural polether with anticarcinogenic properties [4] and determination of absolute stereochemistry of its potential monomer [7]. One of the papers described the first chip-based system for ultra-fast separation of enantiomers based on high-performance liquid chromatography [5] and one paper was accepted for publication about the separation of enantiomers on the stationary phases prepared by covalent attachment of polysaccharide derivatives to the surface of silica [9].

Keywords: Chirality, Chiral Recognition Mechanisms, Enantioseparations

Reference:


9) C. Fanali, S. Fanali, B. Chankvetadze, HPLC Separation of Enantiomers of Some Flavanone Derivatives Using Polysaccharide-based Chiral Selectors Covalently Immobilized on Silica, Chromatographia, in press.
Hydroamination of ferrocene-containing electron-deficient alkenes and alkynes

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The complexes RuCl₂(dmsO)₄ and RhCl(PPh₃)₃ was found to be effective homogeneous catalysts for rearrangement of functionalized aldoximes into primary amides. Several ferrocene-containing amido and cyano alkenes and alkynes have been synthesized. These electron-deficient alkenes and alkynes will be used in hydroamination with primary, secondary amines and N-heterocycles.
Biocomposites on the basis of leaves

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The work is devoted to obtain and investigation of properties of biocomposites obtained on the basis of the renewable raw materials fine dispersive dry leaves and some organic and inorganic binders (phenylethoxysilane, liquid glass, polyethylene, colophony and wood glue).

There were obtained two-component systems at various concentrations of (3, 5, 10, 15, 20\%) binders using the hot pressing method at 150 kg/cm\textsuperscript{2} pressure, 130\degree C temperature. It is established that the resulting physical parameters are dependended on the type of composite and on the binder concentration. For samples Fourier transform infrared spectral (Varian 660 FTIR) investigations have been carried out in KBr.

The composite microstructure of the samples was studied by NMM-800RF/TRF type optical microscope. For composite materials scanning electron microscopic (SEM) investigations and in parallel energy dispersive X-ray spectral analysis have been carried out on the microscope Nikon Eclipse LV 150. The micrograms of SEM were obtained at various (x100- x1000) magnifications. It was shown that the composite materials are pressed well and the binder is distributed regularly and the composites have a fibril structure. Surface analysis, chemical analysis and visualization of composite materials on the basis of leaves shows, that supramolecular structure of samples has a fibril view.

There were investigated the strength at bending, impact viscosity, softening dependence on temperature, water absorption of composites formed by method of hot pressing. It is shown, that the measured physical parameters of these materials essentially depend on their composition - type, concentration and number of binder ingredient.

For example, the composites containing liquid glass, PhES-5- and PhES-80 the mechanical characteristics are in extreme dependence on the binder concentrations – with an increasing of amount of this
binders the mechanical characteristics rises at a certain concentrations further increasing of which leads to decreasing of composites mechanical properties.
Study of Structure of Nonionic Reverse Micelles: Influence of pH of Nano Droplets

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The reverse micelles represent a good model of confined water in biological systems. The biological processes taking place in the reverse micelles approach well their proceeding in membrane environment. The structure of water is complex, besides the structure of water confined in nanometer-scale cavities stands out especially complicated. Due to these circumstances studying of the water properties confined in the core of reverse micelles is topical.

The purpose of the presented work was study of influence of pH of the water droplets on the structure of polyoxyethylene (4) lauryl ether (Brij30) reverse micelles in the presence of kosmotropic and chaotropic ionic additives. Sodium acetate and potassium perchlorate were used as additives.

The microstructure of Brij-30 reverse micelles in the presence of ionic additives was investigated using infrared spectroscopy. Deconvolution of the O-H stretching vibrational absorption spectra in the region of 3000-3800 cm$^{-1}$ into three subpeaks (free, bound and trapped water fractions) with a Gauss fitting program and Monte Carlo method was accomplished. According to infrared spectroscopy data perchlorate ions promote an increasing of free water fraction in the water pockets of the reverse microemulsions at week alkaline pH, whereas acetate ions support formation of the bound water fraction at acidic conditions.

The microenvironment of Brij-30 reverse microemulsions is investigated with ultraviolet-visible spectroscopy by using of ortho-nitroaniline and methyl orange as molecular probes. The values of binding constants and association degrees of ortho-nitroaniline and methyl orange with Brij-30 reverse micelles at different acidity of the water droplets.

Results may be useful in the investigations of water structure, when it is confined to nanometer-scale cavities. Results may be informative in the application of reverse micelles in the field of drug delivery.
Synthesis of new Benzimidazolyl derivatives of Indolo[7,6-g]indole and Benzo[e]pyrrolo[3,2-g]indole

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The reaction of 3-formyl-, 3,6-diformylindolo[7,6-g]indole \[1\] and 2,9-dicarboxybenzo[e]pyrrolo[3,2-g]indole \[2\] with o-phenylenediamine were studied. Condensation and simultaneous cyclization were carried out using different catalysis for determination of reaction optimal areas. As cyclization agents we used glacial acetic acid, polyphosphoric acid and phosphorus oxychloride. 3-(Benzimidazol-2-yl)- and 3,8-bis(benzimidazol-2-yl)-1H,6H-indolo[7,6-g]indole also 2,9-bis(benzimidazol-2-yl)-benzo- [e]pyrrolo[3,2-g]indole were obtained and characterized. The proposed structures are in the agreement of data obtained from IR, UV, and proton NMR spectra.

Thus, new poly-nuclei heterocyclic systems were obtained, which will be interesting at a chemical point of view as studying interconnection of different heterocycles in one molecule, and for further studies of biological activity.
References:


Ecochemical assessment of Tkibuli hard coal

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Despite the fact that combustion products of hard coal belong to the major sources of environmental pollution, its share in modern energy generation reaches 90%. The reason for this are larger deposits of solid fuel in comparison to gaseous and liquid fuels worldwide. As it is well known, the combustion products of hard coal are the powerful source of greenhouse gases and toxic elements, as well as generator of acid rains. Currently the annual production of Tkibuli mines is roughly 0.5 mln. tons. An increase of annual production to 1.0-1.5 mln. tons and construction of thermal power station are considered in the future. Taking into account the above mentioned the ecochemical evalulation of Tkibuli hard coal is topical issue.

The content of regulated substances, such as sulfur, arsenic, chlorine and fluorine was determined in the samples taken from different Tkibuli mines. The official methods recommended by International and Russian regulatory agencies were used for quantitation of the above mentioned components in the hard coal.

According to sulfur content Tkibuli hard coal belongs to ecologically acceptable solid fuel since its total content does not exceed 11.7 g/kg and is equal to 8.5 g/kg average (maximum permitted level is 30 g/kg). Maximum content of arsenic in samples studied reached 5.9 mg/kg, while average content was 2.4 mg/kg. This is far below the allowed limit (0.02%). The volatite form of arsenic equals to 67% of its total content. Nearly the same is the volatite form of chlorine (70%) what can be explained by formation of iron and aluminium chlorides while coal combustion. Contents of chlorides and fluorides are less than permissible limit (average 1.8 g/kg and 8 mg/kg). The humidity in the samples varied from 1.8 to 4.2%, while average ash content was 22.5% ( it varied between 11.8-33.6% ). Iron content in Tkibuli hard coal varies between 0.7-13.1 mg/kg and is equal to 5.0 mg/kg in average.

Thus, based on the results obtained in the present study one can conclude that Tkibuli hard coal represents ecologically acceptable fuel.
Characteristics of enantioseparation of some antimicotic drugs using polysaccharide-based chiral selectors with polar-organic and reversed mobile phases in high-performance liquid chromatography

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Enantioseparation of 8 chiral antimicotic drugs was studied using polysaccharide-based chiral selectors with polar-organic and reversed mobile phases in high-performance liquid chromatography. Antimicotic drugs are diazole and triazole derivatives which are widely used in medicine for heart disease therapy and prevention as well. 5 cellulose and 2 amylose based chiral selectors were used for recent study. Was established effect of structure of chiral selector and mobile phase with different additives on value of enantioselectivity. Addition of ammonium acetate to mobile phase increased the enantioselectivity and generally caused decrease of retention time. Addition of water in case of methanol as a mobile phase increased retention times, but with acetonitrile the trend was different, small concentrations of water decreased retention times firstly but after increasing the percentage of water in mobile phase, values of retention times were increased. Full enantioseparation of Itraconazole was obtained using column Cellulose-4 with 3% water content in mobile phase, but was not separated using column Cellulose-2, in spite of the fact that both are similar chiral selectors with just difference in positions of substitution in benzyl moiety. Full enantioseparation using Cellulose-2 and partial enantioseparation using Cellulose-4 was obtained with Ornidazole. Also, adding of water to mobile phase worsened enantioselectivity in both cases. Ornidazole was not separated enantiomerically using chiral selectors Cellulose tris(3,4-dichlorophenylcarbamate) and Cellulose tris(3,4-dimethylphenylcarbamate) at all. Changing of enantiomer elution order was occurred with Sulconazole by changing the chiral selector, from Cellulose tris(3,5-dichlorophenylcarbamate) to Cellulose tris(2,5-dichlorophenylcarbamate).

Key words: high-performance liquid chromatography, polysaccharide-based chiral selectors, Separation of enantiomers, enantiomer elution order, antimicotic chiral drugs.
Synthesis of derivatives of N-glucozides

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Modification of carbohydrates by various types of organic compounds has recently played a significant role in the synthesis of new of biological and pharmacologically active compounds.

Little has been published about carbohydrates containing nitrozo group. The application of glycosides for the modification of biologically active organic compounds, on the one hand, change their biological and physiological action, and on the other, may reduce their toxicity.

The goal of present investigation consist in synthesis of N-glycosides containing nitrosogroup.

The reaction of N-p-tolyl -β-D-gluco pyran oze (3) and N-p-tolyl -β-D-galactopyran oze (4) with sodium nitrite corresponding nitrosoderivatives have been received (5,6).

\[
\begin{align*}
&\text{R=H, } R^1=\text{OH (1,3,5) glucoza} \\
&\text{R=OH, } R^1=\text{H (2,4,6) galactoza}
\end{align*}
\]
The structures of obtained compounds were established by physical-chemical methods of analysis.

**Investigation of Dimerization Reaction of Ethylene Within the Scope of Quasi-ANB-Matrices Method**

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The schemes of dimerization and cyclodimerization reactions of ethylene are:

\[
2\text{CH}_2=\text{CH}_2 \rightarrow \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \quad (1)
\]

\[
2\text{CH}_2=\text{CH}_2 \rightarrow \begin{array}{c}
\text{CH}_2 - \text{CH}_2 \\
\text{CH}_2 - \text{CH}_2
\end{array} \quad (2)
\]

For investigation of chemical reactions in mathematical chemistry the method of quasi-ANB-matrices (ANB) is efficiently used. Quasi-ANB-matrix is modified contiguity matrix of molecular graph. Its diagonal elements are the sum of atomic numbers of the elements, which structural fragments contain; nondiagonal elements are the multiplicities of the chemical bonds between these structural fragments. Thus, quasi-ANB-matrix can be constructed on the basis of molecular model, that is exceptional case in mathematical chemistry.

The simplest model is elaborated for (1) reaction:

\[
2A = A - A - A - A \quad (3)
\]

where: \(A = \text{CH}_2\). (4) represents this reaction in the form of ANB-matrices:

\[
\begin{pmatrix}
8 & 2 & 0 & 0 \\
2 & 8 & 0 & 0 \\
0 & 0 & 8 & 2 \\
0 & 0 & 2 & 8
\end{pmatrix} \rightarrow
\begin{pmatrix}
8 & 1 & 0 & 0 \\
1 & 8 & 1 & 0 \\
0 & 1 & 8 & 1 \\
0 & 0 & 1 & 8
\end{pmatrix} \quad (4)
\]

Consider the expression:

\[
\Delta_r = \Delta_r - \Delta_i \quad (5)
\]

where: \(\Delta_i\)is the change of determinant of ANB-matrices during the reaction; \(\Delta_r\)– the determinant of ANB-matrix for final state; \(\Delta_i\)– for initial state.

For (4) \(\Delta_r>0\). The value of \(\Delta\) is proportional to the complexity of the system.
Δ~ comp.M
(6)

So, the reaction of ethylene dimerization (1) proceeds with the increase of the complexity of the system. This result is general for addition reactions.

**Synthesis of new derivatives of 5(6)-acyl–2–(1adamantyl)benzimidazole and 5(6)–(1–adamantyl)–2–aminophenylbenzimidazoles**

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The target synthesis and study of adamantane nitrogen containing new structures for viral and bacterial infection and against other biologic agents in order to create new effected means is perspective and actual [1–4]. For the research of wide spectrum biological active new compounds the perspective objects are benzimidazoles and benzoxazoles with active functional groups. For this aim the synthesis of high effective mebendazole (mebenvet, vermoxe) and parbendazole drugs adamantane containing analogs were realized. Particularly, the synthesis of new derivatives of 5(6)-benzoyl-2–(1adamantyl)benzimidazoles, 5(6)–(1-adamantyl)-2–aminophenylbenzimidazoles and benzoxazoles. 5(6)-benzoyl-2–(1-adamantyl)benzimidazoles were synthesized by interaction of 4–benzoyl-o-phenylen-diamine dihydrochloride with adamantane-1-carbonyl chloride in the area of abs. TGF and the obtained compounds cyclization in the area of POCl3. Also by dianimes direct interaction with adamantane containing carboxylic acids in the area of boiling POCl3 and in case of 3–acetylaminoadamantine-1-carboxylic acids by heating in Wood bath in 225–250°C.

The synthesis of new derivatives of 5(6)–(1-adamantyl)-2–aminophenylbenzimidazoles were carried out by condensation 4–(1-adamantyl)-o-phenylenediamine dihydrochloride with aromatic aldehydes in the area of acetonitrile in presence of hydrochloric acid and hydrogen peroxide in the room temperature, or by boiling in the area of absolute ethanol/nitrobenzene. Also 4–(1-adamantyl)-o-phenylenediamines condensation reaction with p-aminobenzoic acid and p-acetylaminobenzoic acid in the area of heating polyphosphoric acid and polyphosphoric acid/xylene were carried out. The optimal conditions of the reaction were established, the corresponding benzimidazoles were isolated. The synthesized nitro derivatives reduction and obtained of amines acylation and aldehydes condensation were studied. The corresponding amides and Shiff bases were obtained.

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**References :**

Investigation of Structure of Water Nano Droplets Confined in Brij-30 Reverse Micelles with an Ultraviolet-visible Spectroscopic Method

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Reverse micelles became very popular in different areas of life sciences [1]. Reverse micelles are isolated, surfactant-coated water droplets, which are frequently used as a model for confined water in biological systems [2]. Nonionic surfactants provide milder environment for encapsulation of enzymes and proteins inside the water nanocages of reverse micelles in comparison with ionic reverse micelles. Therefore nonionic surfactants are used for doping the interface of anionic reverse micelles. Reverse micelles have been investigated with different physicochemical methods depending complex structure of water droplets. Investigation of reverse micelles through the UV-visible absorption spectra of optical probes provides important information about nature of water in water droplets of reverse micelles [3].

The microenvironment of reverse micelles of polyoxyethylene (4) lauryl ether (Brij 30) was investigated with an UV-visible spectroscopic method on the basis of methyl orange (MO) as molecular probe.

The influence of both additives of water and water solutions of some kosmotropic and chaotropic additives on the association degree of methyl orange with reverse micelles was studied. Association degrees of MO with Brij30 reverse micelles were calculated by absorption data of MO at wavelengths of 408 and 416 nm in 0.13 M Brij30 solution in hexane at different water/surfactant ratio (W).

The existence of three types of water is revealed by dependence of methyl orange absorption maxima versus water content in the nanocages of reverse micelles. Different influence of kosmotropic and chaotropic ionic and non-ionic additives on the formation of free water in water core of reverse micelle was observed, viz. the formation of free water in water core of reverse micelle begins at different W in the presence of urea as compared with an additive of glucose. Analogous picture is observed in the presence of ionic additives.

References:
Study of migration order of some of basic drugs' enantiomers in capillary electrophoresis in the presence of Cyclodextrins as chiral selectors

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The separation of enantiomers of chiral basic drugs' such as Isoxsuprine, Butoxamine, Chelpenterol, Terbutaline using by β-cycloextrin, Heptakis(2-3-Diacetyl)β-, Heptakis(2-3-Diacetyl-6-Sulfo)β-, Heptakis(2-6-Dimethyl)β-, and Heptakis(2-3-6-Trimethyl)β-cycloextrins was studied. It was interesting to find that the inversion of the migration order took place only in the enantioseparation of Isoxsuprine in the presence of Heptakis(2-3-Diacetyl)β-cyclodextrine comparing to native β-cyclodextrine. For all other examined in this study chiral compounds enantiomer migration order was the same using above listed cyclodextrins.
Section 7 - Department of Biology

- Biodiversity
- Human and Animal Physiology
- Biochemistry
- Cell and Molecular Biology
- Plant Physiology
- Genetics
- Morphology
- Immunology and Microbiology

Dedicated to the 90th Anniversary of The Birth of Professor Gregory Tumanishvili Doctor of Biology, Corresponding Member of National Academy of Sciences
Morphology

Comparative study of the curative properties of the walnut spread in Georgia by using leukopenia experimental model


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Keywords: walnut, leukopenia, white mouse

Basic life-threatening complications that develop in cancer patients after radiotherapy and/or chemotherapy and caused by decreasing of organism's immune response is still actual problem in oncology. The factors (for example colony stimulation factor) of the different nature used in the medicine to overcome the problem is expensive and besides it have certain negative side effects which is expressed in the stimulation of tumor growth.

Therefore, the study of the natural, plant origin compounds capable to immune correction, are still actual. Special interest is directed to the walnuts (Juglans regia). The medicines obtained from leaves and septum of the walnuts has anti-tumor activity. Positive therapeutic effects of extracts made from walnut septum prepared by different ways are described for a wide range of diseases. It is established that water extract from Greek walnut septum normalizes blood leukocyte formula in adult mice, after one or twice injection of cyclophosphamide which is achieved by stimulation of differentiation of myeloid line in bone marrow and the division of blast cells. Considering that other species of the walnut (American walnut- Pecan- Carya pecan) can be found in Georgia it was interesting to determine if it has similar curative properties.

Aims: comparative study of the curative properties of various walnuts by using experimental model of leukopenia.

Materials and methods: Greek (Juglans regia) and American walnuts (Carya pecan) septum were used for research materials. For estimation of curative properties of walnut septum water extract following methods were used: 1. Determination of leukocytes total amount in the peripheral blood of white mouse; 2. Estimation of cell redistribution according to cell cycle phases by propidium iodide staining method; 3. Chromosomal analysis of mouse bone marrow; 4. Estimation of behavioral parameters changes; 5. Study of sustainability and sorption ability of red blood cells membrane; 6. Determination of catalase activity and the amount of nitric oxide.

Results and discussion: The extracts from American and Greek walnuts septum at the 4th and 8th day after injection of cyclophosphamide showed normalization of cytogenetic indicators, using
experimental model of leukopenia. In addition, the effect is more significant at the 8th day after injection. American walnut septum extract had especially high effectiveness in this case. Normalization of the blood leukocyte formula of adult mice by the walnut septum extract mentioned above, was established. Both walnuts extract causes normalization of the enzyme catalase activity and changes of nitric oxide amount. Increasing the sorption ability of red blood cells, correction of disorder motor activity and some parameters of the learning caused by cyclophosphamide, are revealed by influence of Greek walnut septum. The positive effect of American walnut on the mentioned parameters is expressed relatively slightly.

**Conclusion:** Water extracts of Greek (Juglans regia) and American walnut (Carya pecan) septum have ability to normalize biochemical, genetical, physiological and morphological parameters disordered in response to injection of Cyclophosphamide in adult white mice. Positive effects which were not received in case of American walnut on certain physiological and molecular parameters can be explained by different percentage of content of some components in the walnut septum.
Testing a Novel RNAP I Inhibitor CX5461 that is Highly Specific to Cancer Cell: Effect upon r-genes Transcription and rRNA Processing Nucleolar Factors (UBF, Fibrillarin, B23)

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Keywords: Tumor cell, nucleolus, antitumor drug

This work represents the initial step of common project (in collaboration with Laboratory MEDyC, URCA) targeted on the effect of novel highly specific antitumor compound CX5461 upon r-genes transcription and rRNA processing nucleolar factors UBF, Fibrillarin and B23. Meanwhile, the enhanced interest to this drug is stipulated by its high specificity to malignant tumor cells. Particularly, CX5461 blocks RNAP I activity only in tumor cells having no influence on normal ones. Thus the high efficiency of this drug for clinical application is obvious.

To address the question how specific nucleolar proteins respond to inhibitory action of CX5461 we resort to time-lapse laser confocal microscopy. Our survey was focused on 3D relocalization and 4D dynamics of nucleolar protein factors UBF, Fibrillarin and B23 within nucleolar volume of living He-La culture cells during 16 h of action of CX5461. Tracing behavior of proteins constituting the RNAP I transcription and processing machineries we registered that pattern of the 3D reorganization and 4D dynamics induced by this drug substantially differs from those caused by other RNAP I inhibitors, the widely used and clinically well approved Actinomycin D (AmD) in particular. For example, we noted especially sharp differences observing the behavior of Fibrillarin. Moreover, in overnight experiments we found that CX5461 is less cytotoxic than AmD.
Study of action of low molecular weight components separated from adult rat pancreas thermostable protein complex

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Keywords: protein factors, pancreas, proliferation

Introduction. Most cellular processes are carried out by multiprotein complexes. Hence the important subject of studying is the identification of endogenous protein factors, regulating processes in cells, and its use in the treatment of pathologies. It is known that the thermostable protein complex (TPC) from the adult white rat pancreas, liver, brain and hart through inhibition of transcription decreases cell mitotic activity in the growing rats. TPC is characterized with tissue specificity, that occurs with respect to terminally differentiated cells but it does not show species specificity. The electrophoretic mobility of the protein complex obtained from various tissues is similar (two subgroup of the proteins with mass 12-17 kd and 40-60 kd). At the same time, has not yet determined the contribution of subfraction from cell proteome in above mentioned effects.

The aim of our work was the separation of components with low molecular weight from rat pancreatic thermostable protein complex and study its effect.

Research objects and methods: Investigations were carried out on adult (120-150 g) and infant (8-10) rats. Used methods: the alcohol extraction of thermostable protein complex from adult rat pancreas; the fixation and the preparation of tissue slices for light microscope; determination of mitotic index and native electrophoresis in polyacrylamide gel.

Results: In order to separate the component with low molecular weight from the adult rat pancreatic TPC, the part of the polyacrylamide gel containing this subfraction had been cut out, homogenized, separated from gel and lyophilized. The solution was prepared from lyophilized material and injected intraperitoneally in rats (100 µg/100µl). It was found that low molecular weight subfraction of pancreatic TPC causes decreasing of proliferative activity of hetero- and homotypic tissue in the infant rat. In particular, mitotic index cells of pancreas, liver and heart in experimental animal decreased on average by 50% compared to controls.

Conclusions: The active component of the thermostable protein complex obtained from adult rat pancreas is the fraction with low molecular weight that has ability to inhibit the cell proliferation in either the homo and heterotypic tissues of infant rats.
Spermatozoa endogenous growth inhibitor factor identification and study of it regulation mechanism

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Introduction. Spermatogenesis knows to be regulated by external and internal mechanisms. External regulation involves local regulation mechanisms by pituitary gland and hypothalamus. Internal mechanism of regulation itself includes hormone, neurotransmitter and growth factor production by leydig cells. All above mention products provide the proliferation processes of wide range cells, including spermatogenic. Nowadays men contraceptives are actively testing in many clinics. However usage of such treatment causes warning from the scientists because to suppress spermatogenesis, which takes 72 hours, preparation have to be taken during the long period of time. Based on the information, it would be advisable to use endogenous growth factor instead of hormonal preparation.

Aim of the study. Spermatozoa endogenous grow inhibitor factor identification and study of it mechanisms.

Materials and methods. Adult white rats and human spermatozoa were used for study materials. Thermostable protein complex (TPC) was extracted from the cells by alcohol extraction. Comparative electrophoreses of proteins was performed as well as the study of protein complex influence on cell proliferation. Animals were divided in two groups: 1. Control group - intact newborn rats. 2. Experimental group - animals which were injected 200mkg homologous protein intraperitonealy. After one hour both groups received colchicin injection, and after 2 hour heart, pancreas and testis have been removed under the anesthesia. Paraffin slides were stained by hematoxylin-eosin. The changes of colchicin mitotic index were studied in the tissues under the light microscope.

Results and discussions. It was found that the TPC of adult white rat spermatozoa inhibits the proliferation of homologous cells. The human spermatozoa protein fraction has analogue influence. Spermatogenic cell mitotic index is decreased by an average of 40% in all heterotype organs. Results showed that TPC of spermatozoa does not have species specificity.

Conclusion: 1. Adult rat and human spermatozoa contain thermostable protein complex inhibiting cell proliferation. 2. TPC of spermatozoa is not species specific.
**Immunology and Microbiology**

A study of CD180 and CD32 expression profile on Chronic Lymphocytic Leukaemia cells and MEC1 cell line

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**Keywords:** Chronic lymphocytic leukemia, CD180, MEC1

Chronic lymphocytic leukemia (CLL) is the most common leukaemia in the US and in Europe, including Georgia. Chronic Lymphocytic Leukemia (CLL) presents with clonal expansion and accumulation of CD5+CD19+CD23+ cells in peripheral lymphoid organs and tissues and in bone marrow. CLL is supposedly driven by exogenous or endogenous (auto)antigen(s) and there is increasing evidence that CLL cells receive microenvironmental signals which support their growth, survival and expansion in vivo. We have previously shown that powerful signals are received by CLL cells through CD180 orphan toll-like receptor. Additional accessory signals could be generated through FcγRII (CD32), and both are expressed on CLL cells as well as on control B cells. Here we studied correlation of expression of CD32 and CD180 on CLL cells as well as on MEC1 cell line.

Peripheral blood mononuclear cells (PBMC) from CLL patients and age-matched healthy volunteers were separated, stained with appropriate antibodies to CD19, CD32 and CD180 and analysed by flow cytometry. CD32 and CD180 expression on MEC1 cells was studied at different time-points. The data was statistically analysed using the Mann-Whitney non-parametrical test. Our data indicates that expression of CD32 is significantly increased on CLL cells compared to control B cells as well as in long-term MEC1 cell culture. In contrast, CD180 expression on MEC1 cells significantly decreased throughout 0-96h of MEC1 cell culture. We have recently shown that CD180 ligation can redirect IgM-mediated signaling from pro-survival to pro-apoptotic. This data indicates that a drop in the expression of CD180 on cycling CLL cells might lead to a weakening of this effect and enhance further survival and expansion of CLL cells in proliferative centres of lymphoid tissues. Since MEC1 cells are derived from a CLL patient with mutated IGVH genes (M-CLL) negative correlation between CD180 and CD32 expression on cycling MEC1 cells could be limited to M-CLL.
A promising vaccine candidate for hCGβ specific cancer immunotherapy

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Keywords: Human chorionic gonadotrophin, vaccine

Human chorionic gonadotrophin (hCG) and its β-subunit (hCGβ) are tumour autocrine growth factors whose presence in the serum of cancer patients has been linked to poorer prognosis. Previous studies have shown that vaccines which target these molecules and the 37 amino acid C-terminal hCG peptide (hCG CTP), induce antibody responses in a major fraction of the human recipients. In the present study, we explored the possibility that we could enhance the immunogenicity in mice, of vaccines containing an hCG mutant (BAChCG R68E), designed to avoid cross-reactivity with luteinizing hormone (LH), or hCG CTP itself by coupling the immunogen to different carriers (KLH Hsp70), using different crosslinkers (EDC and GAD) or formulating them with different adjuvants (RIBI and Montanide ISA720). While there was little to choose between KLH and Hsp70 as carriers, and their coupling to hCG CTP was essential for immunogenicity, their influence on the effectiveness of a vaccine containing the BAChCG R68E mutant was less marked, presumably because the protein could provide T-helper epitopes. The mutant provided a significantly better vaccine that the hCG CTP peptide irrespective of the carrier used, how it was cross-linked to the carrier and which adjuvant was used. Highest antibody titres were obtained by linking the antigen to carrier by GAD and using RIBI as the adjuvant, and the lack of cross-reactivity with LH would make this mutant vaccine a promising candidate for therapeutic studies in hCGβ-positive cancer patients.
Biodiversity

Insular distribution patterns of Gorovan Sands (Armenia) on the example of psyllid (Hemiptera: Psylloidea) fauna

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Keywords: Gorovan Sands, Psylloidea, insularity, psammophilous, ecology

The Gorovan Sands Sanctuary is a protected area within the middle reach of the Aras River (South Caucasus, Armenia). This is a patch (200ha) of sandy desert surrounded by clayey and stony deserts. It is home of unique sand-tolerant (psammophilous) plants and animals. Dominant, keystone species of the ecosystem is represented by phog (Calligonum polygonoides). Just such insularism of the Gorovan Sands is determine the uniqueness of the native flora and fauna. Species richness on an islands is highlighted under the equilibrium theory of island biogeography. However, this functional definition encompasses desert oases and other ecotones as well. Although, there are researchers who are supported the nonequilibrium vicariance model of the same phenomenon. I am follower of this, last viewpoint. In the framework of study of the wildlife of the Caucasus, during 1973-1974 was investigated psyllid fauna (Hemiptera: Psylloidea: Pachypsylloidini) of the Aras River Valley. Targeted material on the phog (Calligonum) include four species (two species are new for the Caucasus) belonging three genera. After large disjunction this fragmented fauna is once again appears in the vast sandy deserts of the Middle Asia. Therefore, survival pattern of relict complex of psyllid fauna within minute area of the Gorovan Sands is a quite unusual biogeographic event for the Caucasus biodiversity. On the other hand, three genera of psyllids on phog shrubs represented in Palaearctic (including the Gorovan Sands) are lack within tremendous deserts of Iran, Mongolia, Israel, Arabian Peninsula, and North Africa (restricted only by two genera). We consider that relict fauna of Gorovan Sands should be Plio-Pleistocene derivative of once common area within Irano-Turanian Desert, but the causes how does this fauna survived in this tiny patch under the anthropogenic and other natural press are still enigmatic phenomenon.
Botanical diversity of Wetlands of the Javakheti upland (Lesser Caucasus)

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Keywords: Javakheti upland, Wetland vegetation, Lesser Caucasus

Wetland plant communities are widespread. In the Javakheti plateau are ca. 60 large and small lakes. Items floristical important is Tabatskuri, Paravani, Saghamo, Madatapa, Bughdasheni, Kartsakhi or Khozaphini Lakes with Eurasian, West Asian-Caucasian and European-Mediterranean species such as Carex juncella (considered as a relict species), C. wescaria, C. distachia, C. oreophila, C. medwedewii, C. tristis, C. acutiformis, C. acuta, Calamagrostis canescens, C. neglecta, Sagittaria sagittifolia, Menianthes trifoliata, Utricularia vulgaris etc. Presence of elements of the boreal flora is noteworthy as they presumably penetrated into this area during the Quaternary glaciation through Minor Asia and Middle Asia. Tufted sedge communities are particularly noteworthy of this vegetation type in detail studied on the Javakheti plateau Carices (Carex acuta, C. disticha, C. wescaria) are key components of the mentioned community. Other constituents are: Ranunculus lingua, Poa palustris, Calamagrostis neglecta, C. arundinacea, Comarum palustre, Bistorta carnea, Eleocharis meridionalis, Rumex acetosa, Alisma plantago-aquatica, Utricularia vulgaris, Menianthes trifoliata, Potamogeton gramineus, Elatine alsinastrum, Lemna trisulca, Myriophyllum spicatum, Equisetum fluviatile etc. It is known that these physionomically unique communities are formed in places where the water level changes seasonally.
EcuUiarities of the formation of the zooplankton species composition in two different-type reservoirs in Eastern Georgia

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Keywords: Zooplankton, hydrological regime, filtrators, everyhalinic forms, abiotic and biotic factors.

Sioni and Kumisi reservoirs dramatically differ from each other by their landscape geographical location, size, ground character and form, hydrological and hydrochemical mode. Therefore zooplankton qualitative composition formation in these two reservoirs are characterized with some kind of features: the number of species in Sioni reservoir had been dramatically increased and then had been decreased, and finally had been prevailed percolators. Such changes are connected with the drastic changes of water level. In the Kumisi reservoir the number of species during the formation are reduced more dramatically and finally had been revealed predators. Had been remained evryhaline forms. Mainly these changes are related with the water mineralization changes. The quantitative structure of zooplankton are characterized by drastic changes during the year, which are caused due to the variability features of hydrological and hydrochemical regime, biotic factors (nutritional interdependence).
Species of the genus Rosa L. (Rosaceae) section Caninae DC. in flora of Georgia

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Keywords: Sect. Caninae DC., genus Rosa L. (Fam. Rosaceae), pollen fertility, hybrids, pentaploid somatic status, dwarf forms, karyotype

Sect. Caninae DC. of the genus Rosa L. (Fam. Rosaceae) in Georgia is represented by 23 species (5 species of them are endemic of Georgia and 8 species – the Caucasus endemics). Morphological-geographic analysis of representatives of the sect. Caninae DC. of the Georgia’s flora was performed. We studied the pollen fertility in the herbarium specimens and collected materials. Hybridization occurs not only between species of the section Caninae but also between species of other sections of the genus Rosa (especially many hybrids are known of species R. canina and R. corymbifera). Hybrids like one of the parents or have other new morphological features. There is still much controversy on which roses are true species or species hybrids. The European dogroses (Rosa sect. Caninae (DC.) Ser.) are characterized by a unique meiosis system (“canina-meiosis”), which controls the heterogamous development of tetraploid egg cells and haploid pollen grains resulting in a pentaploid somatic status. The existence of dwarf forms of plants according to some researchers also associated with hybridization. The next step of our search is to study the karyotype of the species that we assume are hybrids.

Genetics
Chromosomal Rearrangement in Lymphocytes of Breast Cancer Patients

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Breast cancer is one of the common malignancies in women. It continues to be a major burden and cause of death worldwide. In Georgian population among the cancer patients 2011 years 42.5 % of women were diagnosed breast cancer and 17% were dead. The majority of cancer cells represent dynamic karyotypic changes, including chromosomal rearrangements. A positive association between the frequency of chromosomal aberrations in peripheral blood lymphocytes and risk of breast cancer has been supported by numerous observations.

In the present study single strand DNA breaks, DNA double-strand breaks (fragile sites of chromosomes) and chromosomal rearrangements were observed. We show that single strand DNA breaks by the method Comet Assay in Breast Cancer patients were 18% (control group -10%). Frequency of fragile sites in cell was 4.14+0.3 (control group -0.42+0.1). Chromosomal aberrations statistically didn't differ from control group.
Was studied the frequency of VKORC1 and CYP2C9 genes different alleles for healthy donors and for patients with thrombosis, in two regions of Georgia – in Samegrelo and in Tbilisi. The relevance of the study due to the interdependence of the studied genes products in the treatment of thrombosis with warfarin. Warfarin is an anticoagulant, causing the inactivation of the VKORC1 gene product, which is one of the clotting factors. The protein product of CYP2C9 gene is involved in the metabolism of warfarin. Genotyping of blood samples for studied genes alleles was carried out using a tube scanner (ESE Quant Tube Scanner), allowing to identify SNPs.

In the studied group of patients with thrombosis from Samegrelo region the wild-type homozygotes by the gene VKORC1 were - 90%; heterozygotes - 10%; mutant homozygotes have not met at all. In the studied group of patients with thrombosis from Tbilisi, also predominated homozygous wild type (60%); heterozygotes were - 40%; mutant homozygotes were not met. The genotypes of healthy donors from Tbilisi does not differed from the same indicator of of Samegrelo (homozygous "wild" AA - 37%; genotype AB - 47%; and mutant genotype - BB - 16%).

In patients with thrombosis, from Samegrelo, wild-type homozygotes and heterozygotes by CYP2C9 gene were almost the same rate (51% and 49% - , respectively); mutant homozygotes were not revealed. In patients from Tbilisi, the frequency of wild-type homozygotes was 70%, heterozygotes and mutant homozygotes was 20% and 10% - respectively. The ratio of the frequencies of CYP2C9 gene alleles in healthy donors from Tbilisi and Samegrelo is not different - wild-type homozygotes - 77%; heterozygotes - 23%; mutant homozygotes in both regions were not met. VKORC1 and / or CYP2C9 genes polymorphisms are presented in a number of clinical dosing algorithms and in prospective clinical trials.

It is revealed the significant variation of genotypes in patients with thrombosis (in both studied regions), which indicates the importance of genotype testing as in treatment process, as well as for the prevention of thrombosis.
Some molecular aspects of prostate tumors development

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The alterations of the physical-chemical characteristics of blood plasma of the men with prostate tumors have been studied. The specificity and diagnostic value of the given alterations has been estimated. Three methods have been used for these purposes: Fluorescence analysis, Differential Scanning Calorimetry and Electrophoresis.

It has been revealed that in men with prostate tumors intensity of the first peak of fluorescence spectra was increased that must be conditioned by the excessive synthesis of plasma proteins associated with tumor growth. The intensity of the second peak was also increased that must be conditioned by the disintegration and reduced activity of enzyme systems during the progression of the disease. The study of the thermodynamic parameters of the plasma proteins revealed the specificity of the observed changes by the given method and the possible diagnostic importance of the scanning calorimetry method; The qualitative as well as quantitative changes of the blood plasma proteins have been established in the men with prostate tumors by the method of electrophoresis.
Biochemistry

Influence of the galactose-spectins lectins, isolated from the prostate gland mitochondria on the redox-status

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In recent years, it has become clear that mitochondria also play a key role in the pathways to cell death. Mitochondrial dysfunction plays a central role in a wide range of age-related disorders and various forms of cancer. In addition, mitochondrial production of reactive oxygen species (ROS) also appears to play a role in carcinogenesis. The numbers of specific compounds, as cytoplasmic, as membrane components have been identified in transformed cells, which are not present in normal cells. Aberrations of membrane components especially are increased in the carbohydrate structures, which condition colonization and metastasis of the tumor cells. The protein-carbohydrate interactions play an important role in the many vital processes, such as cell-cell interactions, which mainly realized by the membrane adhesion molecules with lectin nature. Lectins are biological active proteins, which characterized to bind specifically to the terminal carbohydrates. Therefore, the goal of our experiments were the study the distribution of lectins in mitochondria subtractions’ (outer membrane, inner membrane, intermembrane space, matrix), their carbohydrate-specificity. Mitochondria isolated from prostate post-operative tissue with various diagnoses (normal, N, cytoprostatectomy, benign prostatic hyperplasia, BPH, intraepithelial neoplasia, PIN, atypical adenomatose hyperplasia, AAH). Mitochondrial fractions from human prostatic tissue (for lectin purification) as well as from bovine liver (for study of biochemical changes under the influence of human lectins) were obtained according to De-Robertis (1967) with differential centrifugation.

2. Gal-lectins from mitochondria of prostate hyperplastic tissue with two different pathological forms were purified and their comparative effects on mitochondrial properties were investigated in vitro. Namely, changes in the: (i) amount of H$_2$O$_2$; (ii) redox state of Cu in cytochrome oxidase and (iii) redox state of hem in cyt a+a$_3$ of cytochrome c oxidase complex were studied. Mitochondrial fraction was suspended in the following buffer: 300 mM sucrose, 5 mM Tris-HCl, 5 mM KH$_2$PO$_4$, 0.2 mM succinate, 0.2 mM EDTA and 0.1 % BSA, pH 7.4. Changes in the redox state of copper in cytochrome c oxidase were measured simultaneously and continuously in the thermostat cell ($t$ = 37°C) with a two-channel dual-wavelength spectrophotometer (Specord, Germany). The change in the broad near-infrared band due to oxidized CuA was monitored at 830 nm, using the 722 and 900 nm wavepairs as references, i.e. $\Delta$CuA = $\Delta$A830 nm –($\Delta$A722 nm + $\Delta$A900 nm) / 2 [16]. Mitochondrial fraction was suspended in the buffer of the same composition as described above.

3. Lectin activity was revealed in mitochondria outer membrane (with external and internal carbohydrate binding center), inner membrane and in matrix.

4. Galactose-specific lectins, isolated from the mitochondrial fraction of prostate post-operative hyperplastic tissue of two diagnoses LGPIN and AAH had similar molecular weight and other properties. Effects of these lectins were investigated in vitro model experiments on bovine liver cells mitochondrial properties. Time-dependent changes: (i) in the amount of H$_2$O$_2$; (ii) redox state of Cu in cytochrome oxidase and (iii) redox state of hem in cytochrome a+a$_3$ (cyt a+a$_3$) of cytochrome c oxidase complex were studied. Lectins from both sources increase the amount of H$_2$O$_2$ and decrease the redox state of Cu in cytochrome oxidase and hem in cyt a+a$_3$. However the Lectin from tissue with more severed transformation (AAH) expresses significantly more strong and long-lasting influence. These effects are mediated by galactose binding domain of the lectins as are completely abolished by the inclusion of galactose in reaction medium. Accumulation of H$_2$O$_2$ and long-lasting decrease in the
Redox state of key enzymes of mitochondrial respiration chain could induce defective functioning of these organelles and whole cells. Obtained data points to possible way, which enhances further transformation of prostate tissue by release of galactose-specific lectins from damaged mitochondria.

**Plant Physiology**

**Regulatory role of Endogenous Carbohydrate-binding Proteins and Phytohormones on the Elongation of Coleoptiles cells**

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**Keywords**: carbohydrate-binding proteins, phytohormones, coleoptile, elongation

One of the main branches of plant physiology is the study of phytohormone influence on the regulation of plant life cycle. Interest in this process is conditioned by the fact that hormone–inhibitor balance determines physiological and morphogenetic processes in the plant. According to the recent literature data, besides of the 5 main phytohormones known so far (Auxins, gibberelines, cytochinins, Ethylen, Abscyze acid, Jasmine acid, brasinolydes) new class of hormones was discovered, that includes small signaling molecules of polypeptide nature. Polypeptide signaling is an emerging field in plant biology, particularly in the areas of plant self-defense, fertilization, growth and development. Among those phytohormones mentioned above, auxins are recognized as a major class of plant growth hormones and elicit a wide range of reactivity being responsible for growth and differentiation including cell elongation and cellular differentiation, but the plant science as a whole has much to learn about concrete mechanisms of an action of this plant hormone in the processes of growth and development. Now it becomes more evident that biomolecules containing carbohydrates and with them specifically bending proteins - lectins play key role in control of those physiological processes described above. According to basic data, analogy between nature and molecular mechanisms in the action of plant and animal hormones could be found. Also must be mentioned, that all hormones found in animal cells and their receptors are glycoproteins, main parts of which are lectins. Thus, consideration of plant lectins as plant hormones is of great interest and represents a new dimension in plant physiology.

Based on preliminary works regarding investigation of lectin dynamics in dependence with their content and activity in different organs (root, stem, bud, inflorescent) of mulberry at various stages of their development, supposed possible physiological role of mulberry lectins, which depict their participation in growth and development processes. An activity of exogenic Auxins and growth inhibitors in leaves and inflorescent of mulberry at the different stages of ontogenesis (Apical bud, prefloroscence, florescence and fruitage) have been studied. Maximum activity of stimulating substances is revealed in leaves and inflorescent during the growing period (300-225%). Also in the following phases their content reduces (180-150%). The presence of correlation between the lectin content and the activity of endogenic Auxins in growing leaves and inflorescent is shown. Have been
studied an effect of galactose specific mulberry lectin on plant coleoptiles growth elongation. Quality of purification of mulberry seeds of Gal-specific lectin (MNL) promotes sharp stimulation of growth elongation of wheat coleoptiles. Also has to be mentioned that lectin inhibited by carbohydrate loses its ability to influence growth elongation of wheat coleoptiles. Thus participation of MNL in growth elongation processes is realized by sugar-bounded centers.

**Human and Animal Physiology**

The effects of intracerebral administration of orexins on epileptiform activity induced by electrical stimulation of the CA1 field of the hippocampus in rats

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Orexinergic neurons, the expression of which is marked in the lateral hypothalamus, gives extensive projections throughout the brain and play an important role in both physiological and pathophysiological processes in the brain. The role of orexinergic system in the regulation of synaptic plasticity in the hippocampus is well known [5,6,7], but there is controversy regarding the involvement of this system in pathophysiology of epilepsy[1,2,3,4]. Our previous experiments have shown that orexin-A inhibits pharmacologically induced multiple discharges of population spike in the CA1 field of hippocampal slices, induces a long-term depression of isolated NMDA responses and modulates the activity of spontaneous bursting neurons in the CA3 field of the hippocampus [1,2].

The aim of the present work was to investigate the effects of intracerebral administration of orexins on the electrophysiological characteristics of epileptiform discharges induced by high-frequency electrical stimulation of the CA1 field of the hippocampus.

Our results demonstrate that intracerebral injection of orexin-A increases the threshold of epileptiform discharges induced by high-frequency electrical stimulation and reduces the duration of high-frequency activity. Intraventricular and cortical application of orexin-A also reduces the amplitude/frequency characteristics of the epileptiform discharges.

The noted effects of orexin-A have shown its antiepileptic influence.

References
The role of early postnatal feeding of rats with flavonoids from Saperavi on characteristics of epileptiform activity induced by electrical stimulation of CA1 field of hippocampus

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In recent years the new treatment strategies for neurodegenerative disorders focuses on flavonoids - plant antioxidants, which are characterized by anti-allergic, neuroprotective activity. flavonoids traverse the blood-brain barrier and are able to localize in the brain, with significantly higher levels in hippocampus and cortex, suggesting that they are candidates for direct neuroprotective and neuromodulative actions [2,3]. The hippocampus plays an important role in a learning/memory processes and it is also a common focus site in epilepsy [1].

Our previous experiments showed that early postnatal supplementation with flavonoids from Saperavi grapes have beneficial effects on the hippocampal-related learning mechanisms. Flavonoids from saperavi increases the number of BrdU-positive cells in the dentatus gyrus of the hippocampus, effectively protect the rat brain from kainic acid – induced neuronal injury and memory disruption associated with it.

The aim of the present work was to investigate the effects of early life exposure to flavonoids from saperavy (P7-P15, 25mg/kg per day) on the electrophysiological characteristics of the hippocampal neurons; on the threshold of epileptiform discharges and the properties of high-frequency activity (duration, amplitude envelope, and frequency spectrum).

According to our preliminary data early postnatal feeding with flavonoids from Saperavi increases the threshold of electrically induced epileptiform discharges, inhibits spontaneous hippocampal seizures in a control animals, as well as in a kainic acid rat model of epilepsy.

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References
Influence of flavonoids from Saperavi on learning/memory characteristics and the number of BrdU-positive cells of the gyrus dentatus in the kainate-induced animal model of epilepsy

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Epilepsy is a chronic neurological disease affecting roughly 1% of the human population. The progressive spontaneous recurrent seizures (SRS) induces hippocampal neuronal loss, cognitive impairment and psychiatric comorbidities. Regular treatment with the antiepileptic drugs (AED) is useful for controlling seizures. However, more than 35% of people with temporal lobe epilepsy have chronic seizures that are resistant to AEDs. Thereby new approaches in therapies for easing the frequency and intensity of SRS, learning and memory impairments, and depression in TLE are needed. In recent years the new treatment strategies for neurodegenerative disorders focuses on flavonoids - plant antioxidants, which are characterized by anti-allergic, neuroprotective activity [1,2].

The aim of the present work was to investigate the effects of active flavonoids from Georgian endemic grapes species saperavi on behavioral and morphological alterations induced by kainic acid - status epilepticus. kainic acid rat model of temporal lobe epilepsy was used to define antiepileptic and neuroprotective potency of flavonoids from Saperavi. Our previous experiments showed that early postnatal supplementation with flavonoids from Saperavi grapes have beneficial effects on learning/memory mechanisms. The same doses of Saperavi flavonoids significantly increase the number of BrdU positive cells in the dentatus gyrus of the rats.

The aim of the present work was to investigate the effects of flavonoids from saperavi (25mg/kg per day, 8 days) on kainic acid–induced epileptogenesis, epilepsy associated learning/memory disturbance and neurogenesis in the dentatus gyrus of the hippocampal formation.

Our results demonstrate that exposure of rats with kainic acid epilepsy (15mg/kg, single administration) to flavonoids from Saperavi (8 days, 25mg/kg per day) induces correction of memory impairment induced by epilepsy and this was in correlation with potentiation of the number of BrdU-positive cells in the dentatus gyrus of the hippocampus.

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References
Section 8 - Department of Physics

- Elementary Particles and Quantum Fields
- Condensed Matter Physics
- Physics of Non-linear Phenomena
- Plasma Physics
- Atomic and Nuclear Physics
- Radiophysics, Physical Process Modeling
- Astrophysics

Inter-discipline (Physics, Biology)
- Biophysics

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Motivation of the conducted experiments at ANKE-COSY [1] was absence of experimental data above 1 GeV at small angles (below 35°). From other hand $NN$ interaction, which is fundamental to the whole of nuclear physics, needs precise elastic scattering data as input to a phase–shift analysis ([2] PSA), from which the scattering amplitudes at fixed angles can then be reconstructed. During the experiments the fast proton was detected in the ANKE forward detector (FD) and/or the slow recoil proton in a silicon tracking telescope (STT).

- The differential cross section for proton–proton elastic scattering has been measured at a beam kinetic energy of 1.0 GeV and in 200 MeV steps from 1.6 to 2.8 GeV for centre–of–mass angles in the range from 12°–16° to 25°–30°, depending on the energy. A precision in the overall normalisation of typically 3% was achieved by studying the energy losses of the circulating beam of the COSY storage ring as it passed repeatedly through the windowless hydrogen target of the ANKE magnetic spectrometer. It is shown that the data have a significant impact upon the results of a partial wave analysis. After extrapolating the differential cross sections to the forward direction, the results are broadly compatible with the predictions of forward dispersion relations.

- The proton analysing power in pp elastic scattering has been measured at small angles at COSY-ANKE at 796 MeV and five other beam energies between 1.6 and 2.4 GeV using a polarised proton beam. The asymmetries obtained by detecting the fast proton in the ANKE forward detector or the slow recoil proton in a silicon tracking telescope are completely consistent.

- The charge exchange of vector polarised deuterons on a polarised hydrogen target has been studied in a high statistics experiment at the COSY-ANKE facility at a deuteron beam energy of $T_d=726$ MeV. By selecting two fast protons at low relative energy $E_{pp}$, the measured analysing powers and spin correlations are sensitive to interference terms between specific neutron–proton charge–exchange amplitudes at a neutron kinetic energy of $T_n=1/2T_d=363$ MeV. An impulse approximation calculation, which takes into account corrections due to the angular distribution in the diproton, describes reasonably the
dependence of the data on both $E_{pp}$ and the momentum transfer. This lends broad support to the current neutron–proton partial wave solution that was used in the estimation.

- The vector and tensor analysing powers, $A_y$ and $A_{yy}$, of the pdn[pp] charge-exchange reaction have been measured at a beam energy of 600 MeV at the COSY-ANKE facility by using an unpolarised proton beam incident on an internal storage cell target filled with polarised deuterium gas. The low energy recoiling protons were measured in a pair of silicon tracking telescopes placed on either side of the target. Putting a cut of 3 MeV on the diproton excitation energy ensured that the two protons were dominantly in the $1S_0$ state, here denoted by [pp]. The polarisation of the deuterium gas was established through measurements in parallel of proton-deuteron elastic scattering. By analysing events where both protons entered the same telescope, the charge-exchange reaction was measured for momentum transfers $q > 160$ MeV/c. These data provide a good continuation of the earlier results at $q < 140$ MeV/c obtained with a polarised deuteron beam. They are also consistent with impulse approximation predictions with little sign evident for any modifications due to multiple scatterings. These successful results confirm that the ANKE deuteron charge-exchange programme can be extended to much higher energies with a polarised deuterium target than can be achieved with a polarised deuteron beam.

References:
Octonionic Geometry

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We model physical signals using elements of the algebra of split octonions over the field of real numbers [1-5]. Using explicit representations of the automorphisms on split-octonions, which form the non-compact form of Cartan’s smallest exceptional Lie group G2, it is shown that octonionic geometry naturally exhibit properties of conventional (3+1)-theory (e.g. number of dimensions, existence of maximal velocities, Heisenberg uncertainty, particle generations, etc.) [6]. G2 generates specific rotations of (3+4)-vector parts of split octonions and in infinitesimal limit imitates the standard Poincare transformations, where translations are represented by the non-compact Lorentz-type rotations towards the extra tree time-like coordinates. In our approach elementary particles are corresponded to the special elements of the algebra that nullify octonionic norms (zero divisors). It is shown that the particle spectrum of Standard Model naturally follows from the classification of the independent primitive zero divisors of split octonions [7].

References:
On the Existence of Additional (Hydrino) states in the Dirac and Proca equations

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In case of spinless particles there appear additional (singular) solutions in the framework of relativistic Klein-Gordon equation for Coulomb potential [1-2]. These solutions obey to all requirements of quantum mechanical general principles. Observation of such states (“hydrino, small hydrogen”) should be important for manifestation of various physical phenomena.

In this talk the same problem is considered for spin-1/2 particle (electron) in the Dirac equation. It is shown that such kind of solutions really occurs, but the rate of singularity is more higher than in spinless case. By this reason we have no time- independence of total probability (norm). Moreover the orthogonality property is also failed, while the total probability is finite in the certain area of the model-parameters. Therefore we are inclined to conclude that this additional solution in the Dirac equation must be ignored and restrict ourselves only by normal (standard) solutions. Existence of additional states is also considered in the Proca equation

References

Condensed Matter Physics

Low temperature Technology Receiving Micro and Nano Devices

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1. Shown p-n jantion on n type silicon by stimulated diffusion boron from the unlimit source. 2. Created two gates field effect transisitor, where the gate dielectric HfO2 is received by stimulated plasma anodizing. 3. Shown memristor based on TiO2 received by magnetron sputtering with oxygen and argon defferent parcial presures. Volt-Ampheric characterization shows histeresis, which prufes the high memristive properties.
Control of p-type conduction in Mg doped monophase CuCrO2 thin layers


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In this work our goal was to clarify the origin of hole conduction in undoped and Mg-doped CuCrO2 oxide in order to have possibility to control it by corresponding growth parameters. A chemical spray pyrolysis procedure for deposition of p-type semiconductor thin films is described. As-deposited films were amorphous. Formation of highly crystalline CuCrO2 and Mg-doped CuCrO2 films with single phase delafossite structure was realized by annealing between 600°C and 960°C in nitrogen atmosphere. The carrier concentration and the point defects of samples are calculated by using the developed Kroger method of quasi-chemical reactions. p-type conductivity was observed in undoped and Mg doped CuCrO2 sample predicted, with predicted n~10^18 cm^-3 carrier concentrations. The electrical resistivity for a 4% Mg doped sample was 1.4 Ω·cm with a Seebeck coefficient of +130 µV/K at 40°C. By EPR spectroscopy Cr^{3+} and Cu^{2+} related defects were studied.

Physics of Nonlinear Phenomena
At low temperatures, the anisotropy energy can significantly affect heat capacity of a superparamagnetic “ideal gas”. At sufficiently low temperatures, when the anisotropy energy of uniaxial magnetic nanoparticles exceeds the energy of thermal fluctuations, the anisotropy energy can be expressed as a sum of the energies of two thermodynamic subsystems (two potential wells). One of these subsystems is composed of magnetic nanoparticles oriented predominantly along the axis of anisotropy, and the other – of particles of opposite orientation. There is a similarity between the considered anisotropy energy and the two-level quantum system. Therefore, the temperature dependence of the magnetic part of the heat capacity (similar to Schottky anomaly) will have a sharp peak. At low temperatures, on the curve of the temperature dependence of the heat capacity, besides a usual $T^3$ background, a portion with a pronounced maximum is monitored. The relation between the maximum heat capacity and the magnetic anisotropy constant is derived. Using this relation and measuring the maximum heat capacity at a given temperature, the numerical value of the magnetic anisotropy constant can be obtained.
In some magnetic fluids magnetic anisotropy energy of nanoparticles may significantly exceed the energy of thermal fluctuations even at room temperature, which can largely affect the magnetization process. In case of strong uniaxial anisotropy, a system of magnetic nanoparticles can be formally represented as a set of two thermodynamic subsystems. One subsystem is composed of particles with magnetic moments directed mainly along and the other - opposite to the magnetic field. With the increasing role of anisotropy the shape of the magnetization curve is increasingly different from conventional Langevin form $M \sim L(mB/kT)$ and approaching the Brillouin $M \sim \tanh(mB/kT)$ curve for quantum particles having half spins. The similarity of the considered system with Brillouin one is of purely formal nature and it is explained by the analogy of existing system consisting of two thermodynamic subsystems with quantum macro systems of two-level particles.
Chaotic dynamics and spin correlation functions in a chain of nanomagnets

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We study a chain of coupled nanomagnets in a classical approximation. We show that the infinitely long chain of coupled nanomagnets can be equivalently mapped onto an effective one-dimensional Hamiltonian with a fictitious time-dependent perturbation. We establish a connection between the dynamical characteristics of the classical system and spin correlation time. The decay rate for the spin correlation functions turns out to depend logarithmically on the maximal Lyapunov exponent. Furthermore, we discuss the nontrivial role of the exchange anisotropy within the chain.
Phononic Transistor

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A conceptual mechanism of amplification of phonons by phonons on the basis of a nonlinear band-gap transmission (supratransmission) phenomenon is presented. As an example, a system of weakly coupled chains of anharmonic oscillators is considered. One (source) chain is driven harmonically by a boundary with a frequency located in the upper band close to the band edge of the ladder system. Amplification happens when a second (gate) chain is driven by a small signal in the counterphase and with the same frequency as the first chain. If the total driving of both chains overcomes the band-gap transmission threshold, the large amplitude band-gap soliton emerges and the amplification scenario is realized. The mechanism is interpreted as the nonlinear superposition of evanescent and propagating nonlinear modes manifesting in a single or double soliton generation working in band-gap or bandpass regimes, respectively. The results could be straightforwardly generalized for all-optical or all-magnonic contexts and have all the promise of logic gate operations.

Plasma Physics

Nonlinear nanostructures in the quantum electron-ion gas

Grigol Peradze

In recent years, a huge number of works have been devoted to the investigation of collective behavior of quantum Fermi gas. Such interest is motivated by its potential application in modern technology, e.g. metallic and semiconducting nanostructures – such as metallic nanoparticles, metal clusters, thin metal films, spintronics, nanotubes, quantum well and quantum dots, nanoplasmonic devices, quantum X-ray free – electron lagers, etc. To be based on the new quantum kinetic equation of Fermi particles, which recently was derived by N. L. Tsintsadze and L. N. Tsintsadze [1], a general quantum dispersion equation for electron-ion degenerate Fermi gas, with Madelung term is derived and studied for some interesting cases. Furthermore, then Korteweg-de Vries (KdV) equation for novel quantum waves is derived and contribution of KdV solitons are discussed. New effect that we have shown is that when the quantum (Madelung) term exceeds the term due to the charge separation, the compressional becomes the rarefuction solitons.
Dependence of Degenerate electron gas's specific heat on extrastrong Magnetic field

Davit Buliskeria, N. Tsintsadze

Heat Capacity of Magnetized quantum electron-ion gas D. Z. Buliskeria and N. L. Tsintsadze
Faculty of Exact and Natural Sciences, Ivane Javakhishvili Tbilisi State University, Tbilisi 0128, Georgia. Keywords: Quantized degenerate gas, strong and superstrong magnetic field, Quantum thermodynamics. Abstract Quantum electron-ion gas is becoming of increasing current interest motivated by its potential application in modern technology, e.g. metallic and semiconductor nanostructures- such as metallic nanoparticles, metal clusters, thin metal films, spintronics, nanotubes, quantum wall and quantum dots, etc. Moreover, quantum plasmas are common in compact astrophysical objects (e.g. the interior of white dwarf stars, magnetospheres of neutron stars and magnetars, etc.) In the present report, we wish to undertake the investigation of specific heats in a degenerate electron gas by considering the effect of Landau[1] and Kelly[2] quantization. We consider the effects of the quantizing magnetic field on the heat capacity. Note that the free electron gas for example in metals exists at any temperature even at the temperature of absolute zero. Consequently, it can be regarded that in all temperature regions of metal consists of two subsystems; a crystalline lattice of ions and a free electron gas. Therefore, the heat capacity of a metal can be presented as a sum of two items: $C_V=C_{Ve}+C_{Vi}$ Low temperatures case ($T<<\Theta$- Debye temperature) the total heat capacity equal the sum $C_V=\pi^2/2 K_B ((K_B T)/\epsilon_F)+(12 \pi^4)/5 K_B \left(\frac{T}{\Theta}\right)^3$, when $T<<\Theta<\epsilon_F/K_B$ where $K_B$ is the Boltzmann constant, $\epsilon_F$ is the Fermi energy. We have shown that strong magnetic field leads to increase a coefficient of the electron heat capacity.

Quasi-linear Theory of Quantum Fermi Liquid Oscillations

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Theory of the quantum liquid (isotope of helium He3 at temperature ~1-20K) is due to L. Landau [1] in which L. Landau took into account only the weakly excited energy levels of the Fermi Liquid, lying fairly close to the ground state. In his theory Landau has shown that the undamped zero sound can exist in an almost ideal Fermi Liquid. Quite recently, in the article [2] authors extend Landau’s theory of Fermi Liquids by taking into account the de Broglie waves diffraction, and show that even in an ideal Fermi gas, when the interaction between atoms is absent, the dispersion equation of the zero sound preserves the form. To investigate the problem of existence of the zero sound in He3 Liquid, authors [2] derived a novel quantum kinetic equation. Also authors [2] disclose a new branch of frequency spectrum due to the weak interaction. In this report, we consider the case of many waves with different phase velocities. Such situation takes place in a weakly turbulent quantum liquid. The quasi-linear theory describes the dynamics of the interaction between the resonance He3 atoms and the waves. The quasi-linear theory is able to treat such processes when the energy of the oscillations is appreciably less than the degenerate Fermi energy, but is, at the same, very much greater than the thermal noise energy. The creation of the quasi-linear theory lies in the division of the particle distribution function into two parts: a rapidly oscillating part and a slowly varying part, and also in calculating the influence of the mean square of the oscillating part on the slowly varying part. It is found that the behavior of the slow part of the distribution function can be described by a diffusion equation in momentum space and the rate of damping or growth (instability) of the rapid oscillations is given by the linear theory equations in which the non-oscillating part of the distribution function varies slowly with time. In this paper we used quasi-linear theory to derive diffusion equation in momentum space for particle distribution function and showed that due to de Broglie diffraction, diffusion equation maintains its form, when there is no interaction between He3 isotopes. We also derived the solution for diffusion equation and calculated the mean energy, which depends on time linearly and increases due to diffusion in momentum space.

References
Atomic and Nuclear Physics

Coulomb Impurity Effects on Optical Properties of the System Trapped in Ellipsoidal Confinement Potential

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It has been investigated the influence of the presence of ionized impurity on optical spectra of semiconductor ellipsoidal quantum dots (EQD). For this purpose we calculated eigenfunctions and eigenvalues of electron confined in EQD containing Coulomb impurity. For this purpose first we consider an ellipsoidal quantum dot with rotational symmetry around a given axis (the z axis) and call c and a its axes along the z and x-y directions, respectively. As a model of confining potential we consider the potential that is zero inside the ellipsoid and it is infinity outside. Such model is acceptable either for a quantum dot of a large volume or when the bandgap at the interface is sufficiently large. Using the standard variable change technique one can transform the ellipsoid into a sphere of radius \( r_0 \) with the same volume. Thus the problem of motion of the charge carriers in ellipsoidal well reduces to the study of their motion in spherical quantum dot with new effective potential. The effective potential is proportional to \( \alpha = \frac{r_0^2 (c^2 - a^2)}{(ac)^2} \) which is called as shape anisotropy parameter that reflects the anisotropy of potential well. When \( \alpha \ll 1 \) (i.e. ellipsoid is almost a sphere of radius \( r_0 \)) the problem of finding the charge carrier (electron or hole) energy spectrum in an ellipsoidal quantum dot can be studied with in the perturbation theory as a deformation with respect to the spherical dot.

The optical matrix elements have been calculated for both linearly polarized radiation along the z axis and circularly polarized radiation in the x-y plane relative to transitions from or to the ground state \( |100\rangle \). Dipole transition-matrix elements as well as the momentum matrix elements \( p_z, p_x = (p_x \pm ip_y) / \sqrt{2} \) are calculated as function of \( \chi = c / a \) dot aspect ratio by use of perturbation theory. As a further application the derived wavefunctions can be used for calculation of excitonic states of an electron-hole system and their optical properties trapped in the ellipsoidal well.

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References
Energy levels and wave functions of a particle confined in the potential well of ellipsoidal shape

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A charged particle (electron or hole) confined in the potential well of strongly prolate ellipsoidal shape is considered. The effective-mass Schrödinger equation is solved in prolate spheroidal coordinates and asymptotically exact expressions for the energy spectrum and wave functions are derived. The obtained energy spectrum is in good qualitative and quantitative agreement with the spectrum obtained earlier by numerical solution of the problem in spheroidal coordinates.
Excitation and dissociation processes at collisions of $O^+$ ions with Nitrogen molecules

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For the excitation and dissociation processes for pear $O^+\rightarrow N_2$ cross sections of excitation in the range of energy of ions 0.7 - 10 keV, were measured. The role of metastable $O^+(2D)$ and $O^+(2P)$ of particles in processes of excitation of molecules and products of dissociation was investigated. For studying of effect of orientation of a molecular axis, polarization of radiation of the excited particles was measured. On fig.1 results of measurements of polarization of emission of first band (0,0) system of $N_2^+$ molecule is presented. Results shows that in all energy range, degree of polarization for ions in the ground electronic $O^+(4S)$ state is higher, than for ions in metastable states. Also, in whole energy range, degree of polarization of molecule emission doesn’t change, which means that in process of collision doesn’t change symmetry of ion-molecular system.

Fig.1
Coulomb Sturmian functions in spheroidal coordinates: derivation, properties and application (plenary talk)

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The efficient application of Coulomb Sturmian basis sets in atomic physics makes possible the use of these sets in molecular calculations. For systems of one electron and many centres, calculations with Coulomb Sturmian functions defined in spherical coordinates are reported in several papers; for many-electrons and many-centre systems calculations are much scarce.

Other than spherical polar coordinates, the non-relativistic Schrödinger equation for the Kepler-Coulomb problem is separable in parabolic and prolate spheroidal coordinates. Coulomb Sturmian functions in parabolic coordinates have been derived and investigated in detail. Coulomb Sturmians in spheroidal coordinates are derived in two limiting cases, at small and large distances $R$ between the foci of spheroidal coordinates.

In our recent papers [1-3], spheroidal Sturmian functions are obtained in a closed algebraic form at arbitrary separation $R$. The functions are found by direct solution of the appropriate one-dimensional differential equations written in spheroidal coordinates. The properties of spheroidal Sturmian functions and their application for one-electron and many-electron diatomic molecular calculations are explored and discussed.

![Fig. 1 Coulomb spheroidal Sturmian function $\psi_{010}(\xi,\eta,\varphi)$ at very small, intermediate and large distance $R$ between the foci of spheroidal coordinates.](image)

We continue to work on this problem. Our purpose is to demonstrate that Coulomb Sturmian functions defined in spheroidal coordinates are *naturally* obtained hybrid orbitals that well reproduce the dynamical properties of atomic orbitals, and therefore these functions are the most appropriate basic functions for diatomic molecular calculations.

References:
Near Earth space (ionosphere, magnetosphere) is characterized by complicated dynamics and for modeling of such processes, especially at conditions of external nonstationary impact (bow shock) it is very important an estimation of determined and stochastic parts of the dynamics, as well as the possibility of the generation of large scale wave and fractal structures.

In this work a physical model of the plasma perturbations for experimental data treatment and their physical and theoretical interpretation is obtained. In this model a nonlinear mechanism of interaction of the perturbations with spatially inhomogeneous space flows is considered. From this flows a zonal flow is energetically most important. Numerical simulation of formation of such large scale flows are carried out.

Time series of velocity flow and magnetic field components of the magnetospheric flows observed by THEMIS satellite mission are studied by virtue of nonlinear methods. For numerical treatment of these data a recurrent diagram method is used, which is effective for short data series. Recurrence is a fundamental feature of the dissipative dynamical systems, which is used for analysis of relaxation processes in the magnetotail. The results of nonlinear analysis of plasma perturbations for interpretation is compared with the signals obtained by Lorentz and Weierstrass function. By virtue of recurrent diagram method a fractal nature of experimental signals and dynamical chaos parameters. The results of satellite and numerical simulation data are compared.
Dynamics of protoplanetary disks with rheological viscosity

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We study the linear dynamics of circumstellar disks taking into account rheological properties of the flow that contains gas, dust and debris orbiting central gravitating object. Interaction of solid particles is studied within the granular flow model, when local constitutive equation can be used. In this model we derive 2D equilibrium flow with Keplerian velocity profile and radially stratified pressure, surface density and kinematic viscosity parameter. Kinematic viscosity of the flow depends on the pressure, as well as the velocity shear of the flow.

We use local shearing sheet model and neglect flow curvature to study the linear dynamics of vortex and spiral-density waves under the influence of granular rheology. Using radial rescaling of linear perturbations (see [1]) we derive linear spectrum of the problem and show dissipative properties of individual wave modes. Using isentropic flow model we reduce to barotropic configuration where potential vorticity is conserved apart from viscous dissipation. In this limit we show potential vorticity generation mechanism due to the interplay of background differential rotation and rheological properties of the flow. Process found in granular Keplerian flows can contribute to the generation of large amplitude anticyclonic vortices and promote planet formation at early stages in protoplanetary disks.

**References**

Properties of firehose instability in magnetized inhomogeneous stellar winds

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We study properties of firehose instability in the presence of background velocity shear using anisotropic magnetohydrodynamic (MHD) model with heat fluxes. Collisionless or weakly collision plasma is described within the 16-momentum MHD fluid closure model that has already proved itself successful in the analysis of compressible perturbations in shear flows [1].

In present report we adopt low frequency incompressible formulation and analyze the classical firehose instability in the presence of velocity shear. Constant uniform background magnetic field is parallel to the flow direction. It seems that at low shear rates instability growth rate is modified by velocity shear independent of the heat flux anisotropy parameter. Here are perpendicular to the magnetic field heat flux, pressure and sound speed. At higher shear rates heat flux anisotropy parameter becomes important at higher values of pressure anisotropy parameter. Moreover, instability shows spectral dispersion of the growth rate in the wave-number space and thus depends not only on the streamwise but also on the spanwise wave-numbers.

In general, velocity shear modifies the firehose neutral stability curve that limits perturbations propagating along the stellar winds. Indeed, deviation from standard firehose instability limit can lead observational signatures in solar wind observations that in principle can be used to estimate the spanwise velocity shear of the rarified magnetized flow.

References

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Mechanisms for Multi-Scale Structures in Dense Degenerate Astrophysical Plasmas

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Two distinct routes lead to the creation of multi—scale equilibrium structures in dense degenerate plasmas, often met in astrophysical conditions. By analyzing an e-p-i plasma consisting of degenerate electrons and positrons with a small contamination of mobile classical ions, we show the creation of a new macro scale $L_{macro}$ (controlled by ion concentration). The temperature and degeneracy enhancement effective inertia of bulk e-p components also makes the effective skin depths larger (much larger) than the standard skin depth. The emergence of these intermediate and macro scales lends immense richness to the process of structure formation, and vastly increases the channels for energy transformations. The possible role played by this mechanism in explaining the existence of large-scale structures in astrophysical objects with degenerate plasmas, is examined. The results found in present study indicate that when the star contracts, for example, its outer layers keep the multi-structure character although density in the structures, as shown in [1], becomes defined by lighter components degeneracy pressure.

References

Biophysics
Control of the stability and function for globular proteins by inclusion into the novel type complex environments – self-assembled films and ionic glass-like blends


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Thermodynamic stability (versus temperature-induced phase transitions), conformational flexibility and transformations (hierarchical structural changes), as well as functional performance (specific biological activity) of globular proteins, (typical water soluble “biomolecular machines”) exhibit remarkable diversity. Understanding of physical mechanisms for these phenomena at the molecular level is of paramount importance for the mankind from the viewpoints of the both, general cognition of living matter, as well as practical purposes. Our systematic, interdisciplinary research activity mainly includes thermodynamic and kinetic experimental studies, whereas analysis of the obtained data we perform on the basis of contemporary theoretical concept. The technical basis and equipment for our research are located at the Institute of Biophysics and Bionanosciences of the Department of Physics, TSU and Department of Biophysics of I. Beritashvili Center of Experimental Biomedicine. We also practice systematic collaboration with a number of universities of the USA and Germany. Among the results of research work accomplished in 2015, the following should be mentioned: [1] Studies of electron exchange within the biomimetic nano-dimensional system composed of the copper ion entrapped inside the Au-deposited self-assembled L-cysteine monolayer film, between the Cu ion and the Au-electrode, under the variable temperature and pressure conditions. These studies disclosed the milieu impact that is known as characteristic for cases of the environment’s nonergodic and nonlinear response to the ET process; [2] Studies of electron exchange between the carrying glassy carbon (GC) electrodes decorated by the polymer-modified single walled carbon nanotubes (SWCNT), and the immobilized redox-active, enzymatically active protein, glucose oxidase (GOx). The redoxactive cofactor of GOx, flavine adenine dinucleotide (FAD) is actually involved in two-proton coupled two-electron exchange with the electrode. Our studies revealed that the activated SWCNTs, are able to penetrate into the active center of GOx and directly interact with two FAD moieties within the GOx interior (providing electronic “direct wiring”), thus to virtually act as nanoelectrodes. This action is followed by the concerted redox process specified above; and [3] The horse muscle myoglobin (Mb) was involved in the electron exchange with Au electrodes modified by dissimilar, thin or thick alkanethiol SAMs, terminated either by uni-component (–OH), or 1:1 mixed (–OH/–COOH) groups, respectively. The systematic, temperature- and pressure-supported voltammetry studies perfectly confirmed certainty of two kinds of ET patterns for Mb, embodying: (a) different operational kinetic regimes (including protein’s freely diffusing and strongly confined
motifs), and: (b) different intrinsic physical mechanisms (including dynamically controlled and non-adiabatic motifs).

**Publications:**
The nanotechnology of create new design of drugs and biophysical methods observation on formation microbial biofilms

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Presented by us technology gives opportunity to prepare nanosized liposomes, where it may be incorporated as hydrophobic also hydrophilic molecules for suffer their biological activity when enter living organism. Such packing of molecules into phospholipid liposomes lead to increase possibilities to overcome the damaged organ cell membrane and penetrate into the cell cytoplasm. Therefore such nanoparticles are more effective for treatment diseases. Particularly, by this method we prepared liposomes using DPPC and DPPA lipids, inside of which were incorporated cholesterol, calcium ions and 24nm diameter gold nanoparticles. The common approach were used for preparing all such complex liposomes. Particularly, take into account whether the ligand dissolves in water or in organic solvent on the first stage it is necessary the interaction of ligands with lipids, afterwards it should be added the water (buffer) with temperature slightly above of phase transition temperature of liposomes. Then during one minute the mixture should be shaked intensively. In such way we have got the suspension of complex liposomes. At the last stage using the extruder we get complex liposomes with wishful diameters. As proof that we have got the complex liposomes with presented method the Zetasizer, calorimetric and spectrophotometric method were applied. At the end we want to mention that the presented method is different from those which were used before for preparing complex vesicles. This technology is easy, fast and economic, therefore is cheap. The parameters of complex liposomes prepared by our methods are analogous with those liposomes prepared by previous methods. It needs half an hour to prepare complex liposomes using our method. The Zimm-Ckrozers modified viscosimeter will be used to study the formation of biofilms under the action of different biological active agents. This method allows to continually observe biofilm formation on the surface of liquid media. By this method we will compare the effects of antibiotics and bacteriophages on biofilm formation. On a figure it is given the scheme of observation on biofilm formation dynamic, where the area of biofilm is indicated with arrows. Rotor is hanging into bacterial suspension by surface tension force (in the upper part of the figure), if bacteria starts biofilm formation the speed of rotation of the rotor will reduce.
Micelles Hydrodynamics

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A micelle is an aggregate of lipid molecules dispersed in a liquid colloid. A typical micelle in aqueous solution forms an aggregate with the hydrophilic "head" regions in contact with surrounding solvent, while the hydrophobic tail regions are pointed toward the aggregate center. The aggregation is caused by hydrophobic and hydrophilic interaction of lipids with surrounding water molecules. In mechanical equilibrium conditions micelles are spherical in shape. The shape and size of a micelle are a function of the molecular geometry of its surfactant molecules and solution conditions such as surfactant concentration, temperature, pH, and ionic strength. In order to answer the question “why the shape of micelles are sphere in mechanical equilibrium conditions” it is necessary to consider the motion of micelles in fluid, induced by hydrophobic and hydrophilic interactions. In fluid dynamics material particles can be treated as a vertex of geometric figure and virtual layers as surfaces, and can be searched for equations of motion of such surfaces. The surfaces shall be called a differentially variational surfaces (DVS). We had proposed equations of motion of moving surfaces in aqueous solutions and applied it to analyze micelles morphology in fluid dynamics [1, 2]. Hydrophobic and hydrophilic interaction incorporates dispersive interactions, throughout the molecules, mainly related to electrostatics and electrodynamics (Van der Waals forces), induced by permanent (water molecules) or induced dipoles (dipole-dipole interactions) and possible quadrupole-quadrupole interactions (for instance stacking or London forces) plus ionic interactions (Coulomb forces). The hydrophobic effect can be considered as synonymous with dispersive interactivity with water molecules and the hydrophilic one as synonymous with polar interactivity with water molecules. All these interactions have one common feature and can be unified as electro-magnetic interaction’s dependence on interacting bodies’ geometries, where by geometries we mean shape of the objects’ surfaces [2, 3]. Analytical solution of simplified DVS equations, displayed all possible shapes of micelles spanning spheroids, lamellas, and cylinders. The equations can be applied to problems related to cell motility and growth factors and shows that, in the mechanical equilibrium conditions with the solvent, trace of the mixed curvature tensor is pressure divided on membrane tension [1, 2].

References
Free radicals in biology and medicine (EPR investigations)

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Free radicals—molecules or the part of the molecules, which have unpaired electrons are very active and therefore their discovery or identification is very difficult if we don’t use ultralow temperature or so called “spin-traps”. In this presentation we have discussed the ways of identification of the free radicals and also the ways of their neutralization. β-tocopherol, (vitamin-E), α-Cell death, tissue injury caused by oxidative stress and inflammation processes are included in many diseases, like cancer, neurological diseases (Alzheimer’s disease, Parkinson’s disease and etc), diabetes, cardiovascular diseases, aging and etc. The role of free radicals involved in metabolic processes are very important, but the free radicals generated during oxidative stress mainly are very dangerous for life. Their increased number caused by different metabolic processes are very dangerous, but human body owns multiple possibilities to fight against unwanted free radicals. They are: Ascorbic acid (vitamin-C),