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Enantiomers Present in Serum Carry Cancer and/or Recovery Status Information

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Abstract

Human blood serum of cancer, cancer-recovered and healthy patients contains laevorotatory and dextrorotatory B^2 active molecules. The laevorotatory B^2 active carriers in patient serum carry information on the cancer status while the dextrorotatory B^2 active carriers carry information on the recovered and/or healthy patient status. Their magneto-optical characteristic is analysed by the B^2 Magneto Optical Circular Birefringence. By applying the *MOCB* experimental technique, it is possible to differentiate between the cancer and non-cancer patients. The paper introduces a purely molecular physics approach for description of the cancer/recovered and also non-cancer patients status.

Keywords

Cancer, Serum Optical Activity, Enantiomers, Electric Quadrupole, Magnetic Dipolar Molecules

1. Introduction

It has been established and summarized [1] that measurements of magneto-optical birefringence in the human blood serum bring information on the cancer status of the patient. This paper is based on the Magneto Optical Circular Birefringence *MOCB* results published although in this paper they are analysed in an aspect of enantiomers electric quadrupole and magnetic dipolar molecules present in serum of cancer, cancer recovered [2] patient. The electric quadrupole and magnetic dipolar carriers so far have not been detected by the biochemical methods in blood serum. The magneto-optical birefringence of ovarian cancer, prostate cancer, rectal cancer, mammae cancer and others, the number of molecular carriers of information about the cancer status allowing quantitative evaluation on the cancer development ${}^{(-)}\rho$ and also the number of carriers ${}^{(+)}\rho$ informing about the effectiveness of cancer therapy and/or cancer-free status. As follows from *MOCB* measurements, the blood serum of cancer patients contains laevorotatory molecules (−), case ${}^{(-)}\rho \gg {}^{(+)}\rho$, while that of the same patients

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after effective therapy contains dextrorotatory molecules (+), case ${}^{(+)}\rho \gg {}^{(-)}\rho$. That has been firstly signalled and implied in [1] [2]. Physical technique of the method is measurement of the serum optical birefringence.

2. Experiment

The values of *MOCB* markers obtained for cancer patients and for the same patients after successful therapy are given in **Table 1**, along with the values of biochemical markers informing about the clinical diagnosis of cancer and clinical diagnosis of effective therapy. The experimental *MOCB* technique applied for ovarian cancer serum [3] and enantiomers B^2 chirality investigation [4] of the neat chiral molecules were published since 1997. Physical basis of the method [5], is measurement of the serum optical birefringence $\alpha(B^2)^{exp} = (\alpha^+ - \alpha^-)$. The symbols α^+ and the α^- denote the B^2 magnetic field induced optical activity of the molecular carriers present in the serum. *MOCB* marker $b^{exp} = \left(\alpha^+ - \alpha^-\right) \big/ 2B^2L$ where L is the light path in the serum. The patients data $(\alpha^+ - \alpha^-) < 0$ indicate cancer status while $(\alpha^+ - \alpha^-) > 0$ are characteristic of the recovered and of the non-cancer patient serum.

3. Results

The values of *MOCB* markers obtained for cancer patients and for the same patients after successful therapy are given in **Table 1**.

Table 2 presents the *MOCB* results evidencing the presence of laevorotatory enantiomer (−) in the blood serum of the patients diagnosed with cancer and the presence of dextrorotatory enantiomer (+) in the blood serum of the same patients after successful therapy.

Table 3 presents *MOCB* data [4] obtained for chemically pure enantiomers: tartaric acid, lactic acid and α-methylbenzylamine to illustrate the molecular structure of electric quadrupole, enantiomer (−), and that of magnetic dipole, enantiomer (+) in comparison to the enantiomers present in the blood serum.

The laevorotatory enantiomer (−) of the chemically pure molecule have a molecular structure of electric quadrupole, while the dextrorotatory one (+) has a molecular structure of magnetic dipole [4]. The density numbers ${}^{(-)}\rho_o$ and ${}^{(+)}\rho_o$ of given chemically pure enantiomers (−/+) are the same. So, the quotients ${}^{(-)}b^{exp}/{}^{(-)}\rho_o$ and

Table 1. Cancer, recovered, non-cancer serum *MOCB* data.

	Ovarian cancer		Prostate cancer		Rectal cancer		Mammae cancer	
Marker:	Ca125		tPSA(ng/mL)		CEA/(ng/mL)			
Clinical diagnose	87.99	-	7.570	1.183	1.0	-	-	-
MOCB data	After therapy		After therapy		After therapy		Healthy patient	
$10^5\ b^{exp}$	−20.8	20.0	−17.0	16.6	−20.0	20.0	−19.0	20.0
$10^3\alpha(B^2)^{exp}$	−2.08	2.0	−1.7	1.66	−2.0	2.0	−1.9	2.0
$10^3\alpha(B=0)^{exp}$	32.18	38.15	47.28	47.53	40.21	38.35	49.00	38.96
$10^{-18}\ {}^{(-)}\rho$	3.74	-	3.04	-	3.60	-	3.54	-
$10^{-18}\ {}^{(+)}\rho$	-	3.50	-	2.98	-	3.50	-	3.50
$10^{51}\ S_q$	1.35	-	1.35	-	1.35	-	1.35	-
$10^{34}\ R_q$	-	2.05	-	2.05	-	2.05	-	2.05
Enantiomers:	(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)

$b^{exp}/(degT^{-2}\cdot mm^{-1})$, $\alpha(B^2)^{exp}/(degT^{-2}\cdot mm^{-1})$, $\alpha(B=0)^{exp}/(deg\cdot mm^{-3})$, ${}^{(-/+)}\rho/(carriers\cdot mm^{-3})$, $S_q/(deg^{-1}T^{-2}J^{-1}A^2m^3s^2)$, $R_q/(T^{-2}J^{-1}A^2m^3s)$.

Table 2. Enantiomers presence in serum of cancer/recovered patient.

	Ovarian cancer	Prostate cancer	Rectal cancer	Mammae cancer
${}^{(-)}\alpha(B^2)^{exp}/{}^{(+)}\alpha(B^2)^{exp}$	−1.04	−1.02	−1.00	−0.98
${}^{(-)}\rho/{}^{(+)}\rho$	1.06	1.02	1.03	1.01
$\alpha\left(B=0\right)^{exp}_{cancer} = \alpha\left(B=0\right)^{exp}_{recover}$	0.84	0.82	0.92	0.79
${}^{(-)}\alpha\left(B^2\right)^{exp} \big/ \alpha\left(B=0\right)^{exp}_{cancer}$	−0.06	−0.036	− 0.05	−0.04

Table 3. Selected homogeneous chemically pure enantiomers *MOCB* data.

	α-Methylbenzylamine		Tartaric acid		Lactic acid (1 g in H_2O)	
$10^5\,b^{exp}$	−0.275	0.275	−0.118	0.118	−0.05	0.05
$10^{5\,(-/+)}\alpha(B^2)^{exp}$	−2.75	2.75	−1.18	1.18	−0.5	0.5
$10^3\alpha(B=0)^{exp}$	−1.07	1.07	−0.58	0.58	−4.0	4.0
$10^{-20\,(-/+)}\rho_o$	2.12	2.12	2.25	2.25	2.58	2.58
$10^{55}\,S_q$	3.15	-	1.27	-	0.47	-
$10^{38}\,R_q$	-	4.65	-	1.82	-	0.78
Enantiomers:	(−)	(+)	(−)	(+)	(−)	(+)

$b^{exp}/(degT^{-2}\cdot mm^{-1})$, $\alpha(B^2)^{exp}/(degT^{-2}\cdot mm^{-1})$, $\alpha(B=0)^{exp}/(deg\cdot mm^{-3})$, $^{(-/+)}\rho/(carriers\cdot mm^{-3})$, $S_q/(deg^{-1}T^{-2}J^{-1}A^2m^3s^2)$, $R_q/(T^{-2}J^{-1}A^2m^3s)$.

$-^{(+)}b^{exp}/^{(+)}\rho_o$ take the same values. For the serums of cancer patients and healthy subjects the relations following from the magneto-optical characteristics are: $^{(-)}\rho = 1.79\left(-^{(-)}b^{exp}\right)10^{22}$ and $^{(+)}\rho = 1.79\left(^{(+)}b^{exp}\right)10^{22}$.

The $^{(-/+)}b^{exp} = {}^{(-/+)}\alpha\left(B^2\right)^{exp}\Big/\left(2B^2L\right)$ of cancer state (−) and cancer-free state (+) are obtained by *MOCB* measurements for normalised volume of blood serum V_{eff} = 15.7 mm^3 and light path L = 5 mm of λ = 488 nm passed through a given serum sample. For cancer patients, the total number of molecules ($^{(-)}\rho + {}^{(+)}\rho$) in 1 mm^3 of serum depends on the advancement of cancer $^{(-)}\rho$ and irrespective of the advancement of the disease, the value of *MOCB* relation $^{(-)}b^{exp}\Big/\left(^{(-)}\rho\right)$ is constant. Similarly, for cancer-free patients, ($^{(+)}\rho \gg {}^{(-)}\rho$), the value of *MOCB* relation $^{(+)}b^{exp}\Big/\left(^{(+)}\rho\right)$ is constant, irrespective of the changes in the number of dextrorotatory carriers $^{(+)}\rho$ in serum of recovered and/or healthy patient. For these patients the magneto-optical parameters of blood serum meet the same condition as met for chemically pure enantiomers.

In the process of effective therapy, the number of laevorotatory carriers $^{(-)}\rho$ decreases, while that of dextrorotatory ones $^{(+)}\rho$ increases. An increase in $^{(+)}\rho$ to the level $^{(+)}\rho = {}^{(-)}\rho$, means that the serum of this donor contains the same number of dextrorotatory (+) and laevorotatory (−) enantiomers, see **Table 2**. This equality means that the blood serum of the cancer patient and the blood serum of the same patient after successful therapy contain the same number of different sign enantiomers, the cancer patient serum contains enantiomer (−), electric quadrupole molecules while the serum of the same patient after successful therapy contains enantiomer (+), magnetic dipolar dextrorotatory molecules. For $^{(+)}b^{exp} = -^{(-)}b^{exp}$ and $^{(+)}\rho = {}^{(-)}\rho$ the number of $^{(+)}\rho$ information carriers in the serum of healthy subjects and patients recovered from cancer is equal to the number of $^{(-)}\rho$ information carriers in the serum of cancer diagnosed patients (prior to therapy). So, the electric quadrupolar optical polarizability tensor S_q= const for cancer patients serum, while for cancer-free patients serum the magnetic dipolar optical polarizability R_q = const, because $^{(-/+)}b^{exp}/(^{(-/+)}\rho)$ = const similarly like for the enantiomers of a selected optically active chemical compound, e.g. tartaric acid and others, (**Table 3**).

Therefore, the measurement of $\alpha\left(B^2\right)^{exp} = \left(\alpha^+ - \alpha^-\right) < 0$ gives $^{(-)}\rho$, as *MOCB* does not detect $^{(+)}\rho$ because $^{(+)}\rho \ll {}^{(-)}\rho$ and the measurement of $\alpha\left(B^2\right)^{exp} = \left(\alpha^+ - \alpha^-\right) > 0$ gives $^{(+)}\rho$, as *MOCB*, $^{(-)}\rho \ll {}^{(+)}\rho$, does not detect $^{(-)}\rho$ because $^{(-)}\rho \ll {}^{(+)}\rho$. *MOCB* detects the enantiomer (−) in the blood serum of cancer patients and the enantiomer (+) in the blood serum of the same patient but only when—as a result of successful therapy—his/her blood serum is characterised by $^{(+)}b^{exp} = -^{(-)}b^{exp}$ and $\alpha\left(B=0\right)^{exp}_{cancer} = \alpha\left(B=0\right)^{exp}_{recover}$.

In the magnetic field B = 0, the rotation α_t of the light polarization plane by the medium is a resultant of natural optical activity of all components of the medium. Thus, α_t is the resultant of laevorotatory and dextrorotary rotations and does not bring information of the separate contributions. The rotation of the polarisation plane of light passed through the blood serum of cancer patient in zero magnetic field is $\alpha\left(B=0\right)^{exp}_{cancer}$, which is equal, within an experimental error, to $\alpha\left(B=0\right)^{exp}_{recover}$, the rotation of the polarisation plane of light passed through the blood serum from the same donor after successful therapy, see **Table 2**. The presence of enantiomers in the blood serum of prostate cancer has been [2] the first enantiomers identification in serum. In this study, the blood serum samples analysed came from patients suffering from ovaries cancer, prostate cancer, rectal cancer and mammae cancer.

The search for the laevorotatory and dextrorotatory molecular markers by any method involving denaturation

techniques is the wrong choice as denaturation causes destruction of such markers. Measurements of rotation of light polarization plane induced by the magnetic field of induction B = 0 and measurements of *MOCB* effects in blood serum samples were made with the accuracy to ±5%.

4. Discussion

The *MOCB* results could be complemented by biochemical measurements of protein markers (*FSH receptor protein*), Radu *et al.* [6] and Wong *et al.* [7] identify and discuss the localisation of cancer cells for different cancer case diagnoses. Prostate cancer data [2] and the present paper *MOCB* results are the molecular markers of cancer/healthy patients. Analysis of the magneto-optical characteristics of blood serums of cancer and cancer-free patients indicates that the number of laevorotatory molecules higher than that of the dextrorotatory ones can be a molecular marker of cancer state. In this paper the presence of such molecules and enantiomers in blood serum were analysed and indicate presence of only 3.6% to 6% of the B^2 active electric quadrupole carriers in the cancer serums (**Table 2**).

The paper by Zawodny *et al.* [8] concerned the contributions of optically electric active molecules of the structure of electric quadrupole and magnetic dipole in the total rotation of light polarization plane induced by magnetic field of induction B^2 for the light passing through a medium of natural optical activity. The presence of laevorotatory and dextrorotatory enantiomers and the electric quadrupole and magnetic dipolar carriers so far have not been detected by the biochemical methods in blood serum.

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