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Natural Terrestrial electromagnetic fields of extremely low frequencies and detection of periodic gravitational radiation

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Abstract

The present research is connected with nontraditional ways of detecting periodic gravitational radiation. Some records of extremely low frequency variations of electromagnetic fields of Earth with extracting periodicities are realized corresponding to the source of gravitational radiation of geophysical and astrophysical origin.

Introduction

Our research contains theoretical and experimental investigations of the interrelation mechanism between extremely low frequencies (ELF) electromagnetic fields in the Earth-ionosphere cavity and periodic gravitational fields of geophysical and astrophysical origin. From theoretical and experimental points of view the problem of indirect detection of periodic signals of local and global gravitational fields through induced electromagnetic fields is quite possible. Our approach is novel and it uses the ELF electromagnetic fields detector system situated at Vladimir State University (VSU).

The foundation of the theory of interaction of the gravitational waves (GW) with quasi-static electromagnetic fields is given in [1]. Applying this theory to the natural electromagnetic field of Earth one can conclude that gravitational radiation coming to our planet generates electromagnetic oscillations in the Earth ionosphere. In papers [2,3] the idea of multiparametric electromagnetic wave modulation with the field of periodic gravitational radiation is developed. Apart from the generation of ELF radio waves with frequencies of periodic gravitational source, these papers also look at induced nonlinear electromagnetic radiation selfaction in the environment of gravitational radiation source. Up to now experimental investigations in this direction have been practically absent because of the insufficient rate of transformation. However, at present there exist theoretical predictions which allow one to examine the possibility of solving this problem [4] and to analyse information accumulated by the detection system at VSU. The most perspective sources of the gravitational radiation, according to the latest theoretical results [5], are the following objects: relativistic double pulsars, the Sun radiation in the field of remote sources of periodic gravitational radiation and Earth's ionosphere in the field of remote gravitational sources.

2. Natural electromagnetic field of the Earth of extremely low frequencies

Extensive investigations in the ELF range took place recently in radio navigation, in underwater and underground radio communication and in geophysics as well as in examining the ionosphere and the magnetosphere. Such electromagnetic fields spread practically without any decay at great distances and penetrate the water and the ground. Numerous natural phenomena such as thunderstorms, volcano eruptions, earthquakes and oscillations of the electromagnetic field give rise to variations of ELF electromagnetic Earth's fields (below 30 Hz) and measurements of ELF electromagnetic fields should contain hints of how to separate information from their sources.

ELF electromagnetic fields in the void Earth ionosphere can be excited by natural sources of two types: terrestrial (of which the main source are thunderstorm discharges) and cosmic ones. The cosmic origin of the electromagnetic oscillations, which are observed on Earth surface in ELF range, is reliably determined to a high degree of accuracy in [5]. It is said there are regular and irregular oscillations of geomagnetic field from few mHz to few Hz. Oscillations also appear in the Earth's magnetosphere [6].

The spectral density level of ELF oscillations is of an order higher than the average spectral density level of the noise observed in Earth's ionosphere cavity. Therefore the contribution of space sources to the recorded signal on the Earth surface should be compared with the contribution of the world thunderstorm activity [5]. Detection of electromagnetic fields changing with the gravitational wave frequency, such as signals coming from relativistic double systems can be an indirect confirmation of the existence of gravitational radiation.

3. ELF electromagnetic fields detection system and correlation processing of the experimental results got in 1997.

Since 1972 investigations of ELF electromagnetic fields have been carried out at the Experimental Base of VSU Chair of Physics. The purpose of the research is to study fields accompanying earthquakes, eruptions of volcanos and thunderstorms. A detection complex has been constructed for this purpose, and contains ground, underground and underwater detectors located over an area of 40 000 m^2. The complex allows to detect ELF signals with some background interference during long time intervals, to perform signal correlative processing of long duration, to get daily and seasonal fluctuations, the correlation distance of the interface and the law of ELF field distribution [8,9]. It has been shown that unique possibilities appear when underground and underwater detectors are combined with ground-based detectors. In order to extract useful information substantial data has been accumulated for determination of the noise-distribution law, the spectral and correlation characteristics of the recorded variations, the period of the stationarity intervals and data for the correlation processing of detected signals. A unique detector graduation method has been developed and now it is used to evaluate the recorded field intensity in absolute units.

Since 1993 a search for correlations between ELF electromagnetic fields and gravitational fields of double pulsars, whose radiation frequency is well-known, has been carried out on the initiative of the laboratory of the gravitational waves astronomy of Kazan University (the catalogue of the pulsars is given in [7]). Processing of experimental data is carried out by quadrature detector correlation of signals with known frequency (the pulsar one) and unknown phase. The results of preliminary correlation processing on the base of data obtained since 1975, for extracting periodicity corresponding to double pulsar radiation, allowed to conclude that it is necessary to make continuous synchronous recording of electromagnetic fields over a long period of time (for months and years) by a multiple detector system. In 1997 an attempt to perform such an experiment was realized at the VSU experimental base. The experiment involved synchronous recording of the electrical component of earth origionated ELF by ground and underground detectors. Meteorological conditions (temperature, pressure, humidity, the presence of the seismic centers) were recorded throughout data collection.

Examples of correlation processing during a month of continuous recording by ground and underground level channels are given in Figures 1,2,3,4.

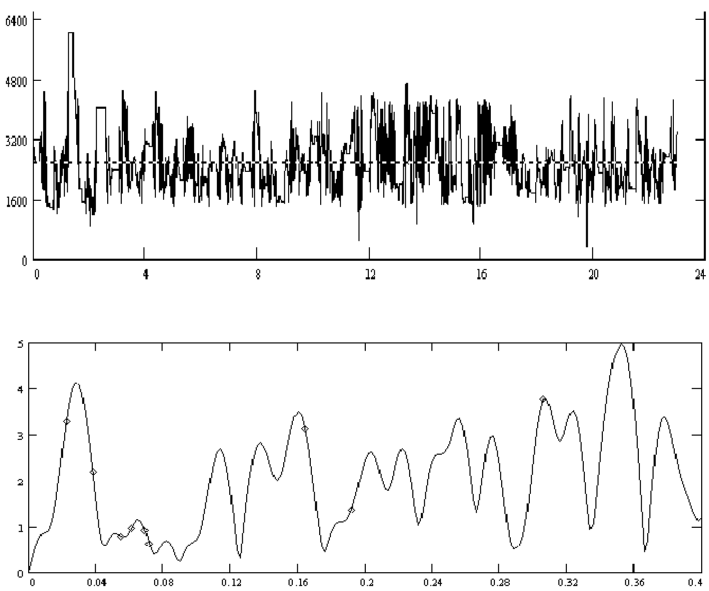

Figure 1.

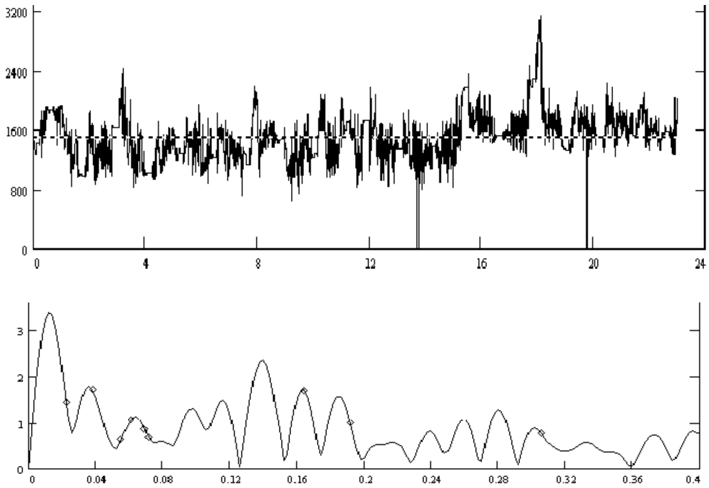

Figure 2.

Several classes of periodic signals has been extracted from data which have been practically fixed by all detectors. Steady signals are observed near the frequencies of the sources: PSR 1012+5307(f=3.8301527 E-5Hz); PSR 1059+2048 (f = 6.0633277 E-5Hz); PSR 1913+16 (f = 7.1702866 E-5Hz); PSR1910+0004 (f =16.425918 E-5Hz); PSR 1748-24269A (f = 30.616097 E-5Hz).

The results of the correlative processing should be considered as preliminary because reliable estimation of the signal from the source can only be carried out in analysis of continuous measurements during a long period of time (a month, a year), dictated by the source frequencies. It is hoped that the adopted methods of detection and accumulation of experimental data during long time periods and subsequent processing and processing methods will promote further research into nontraditional methods of detecting periodic gravitational fields of geophysical and astrophysical origin.

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