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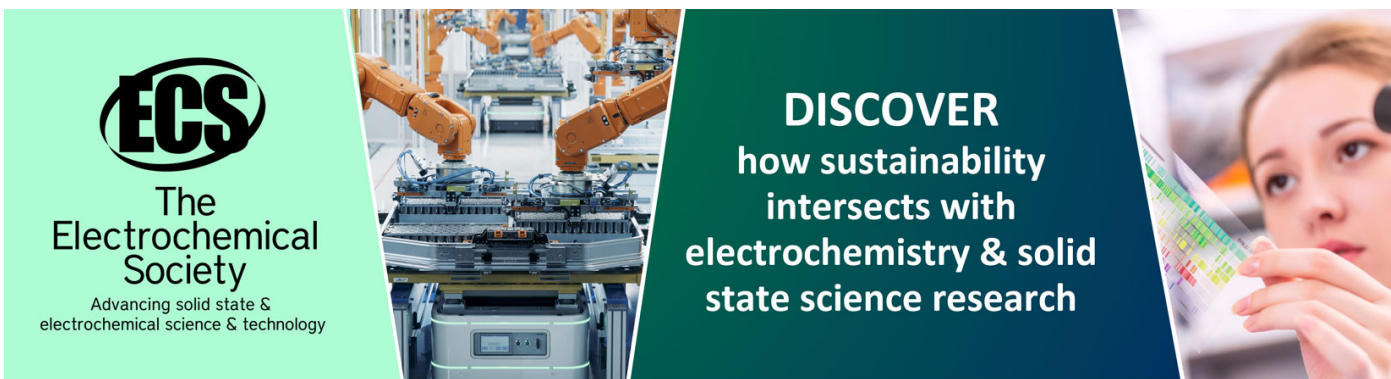
Possible influence of the polarity reversal of the solar magnetic field on the various types of arrhythmias

To cite this article: E Giannaropoulou *et al* 2013 *J. Phys.: Conf. Ser.* **409** 012239

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Possible influence of the polarity reversal of the solar magnetic field on the various types of arrhythmias

E Giannaropoulou¹, M Papailiou¹, H Mavromichalaki¹, M Gigolashvili², L Tvildiani³, K Janashia³, P Preka – Papadema¹, Th. Papadima⁴

¹ Nuclear and Particle Physics Section, Physics Department, National and Kapodistrian University of Athens, Athens, Greece

² E. Kharadze Abastumani Astrophys. Observ. Ilia State University, Tbilisi, Georgia

³ Helio-Magneto-Cardiological Scientific and Practical Center, Tbilisi, Georgia

⁴ General Hospital of Athens 'EVAGELISMOS', Intensive Care Unit, Athens, Greece

E-mail: mpapahl@phys.uoa.gr

Abstract. Over the last few years various researches have reached the conclusion that cosmic ray variations and geomagnetic disturbances are related to the condition of the human physiological state. In this study medical data concerning the number of incidents of different types of cardiac arrhythmias for the time period 1983 – 1992 which refer to 1902 patients in Tbilisi, Georgia were used. The smoothing method and the Pearson r-coefficients were used to examine the possible effect of different solar and geomagnetic activity parameters and cosmic ray intensity variations on the different types of arrhythmias. The time interval under examination was separated into two different time periods which coincided with the polarity reversal of the solar magnetic field that occurred in the years 1989-1990 and as a result a different behavior of all the above mentioned parameters as well as of the different types of arrhythmias was noticed during the two time intervals. In addition, changing of polarity sign of the solar magnetic field was found to affect the sign of correlation between the incidence of arrhythmias and the aforementioned parameters. The primary and secondary maxima observed in the solar parameters during the solar cycle 22, also appeared in several types of arrhythmias with a time lag of about five months.

1. Introduction

The possible effect of solar, cosmic ray and geomagnetic activity on human health has been the subject of ongoing research. Important results emerged from studies of cardiovascular diseases or diseases of the nervous system such as stroke, myocardial infarction or even accidents [1] and from surveys that examine changes in human physiological parameters like heart rate and arterial systolic and diastolic pressure [2], [3]. Several studies have been made to investigate heart rhythm disturbances in relation to solar and geomagnetic activity. It was shown an inverse relationship between the frequency of cardiac arrhythmic events and the level of daily geomagnetic activity (GMA) [4]. It was also observed a 27-day periodicity of the incidence of arrhythmias and a possible effect of the polarity sign change of the interplanetary magnetic field on the rate of the incidence of arrhythmias [5]. This study is a result of the collaboration of two different scientific groups, from Athens (Greece) and Tbilisi (Georgia). The results that are presented concern mainly the influence of solar, geomagnetic and cosmic ray intensity variations on the occurrence of cardiac arrhythmias.

2. Data and Method

A group of 1902 patients with ages from 30 yr to 75 yr with ischemic heart disease was supervised and medical data concerning the number of incidents of Supraventricular extrasystols (S), Supraventricular paroxysmal tachycardia (Ps), Ventricular single extrasystols (V1) and Ventricular multiple extrasystols (Vm) were statistically collected with daily Holter-monitoring and ECG-recording from different hospitals of Georgia. This particular study refers to the time period 1983 – 1992 covering almost one complete solar cycle.

The smoothing method and the Pearson r-coefficients were used to examine the possible effect of different solar and geomagnetic activity parameters (such as sunspot number, solar flares, proton events, interplanetary magnetic field, Dst and Kp indices) and cosmic ray intensity (CRI) variations on the aforementioned types of arrhythmias.

Daily pressure corrected data of the CRI were obtained from Moscow Neutron Monitor Station (24NM64, cutoff rigidity 2.43 GV). The geomagnetic indices Dst and Ap were obtained from the online data base Space Physics Interactive Data (<http://spidr.ngdc.noaa.gov>). The total number of Solar Flares for the aforementioned time period was obtained from the National Geophysical Data Center (NGDC). (<ftp://ftp.ngdc.noaa.gov>). For the analysis, the total number of solar flares, the number of solar flares C and the number of solar flares >M were used. The total daily number of Solar Proton Events (SPEs) for each day was obtained from the Proton Events Database (<http://cosray.phys.uoa.gr>) [6].

The Statistical method of Exponential Smoothing was applied on a 365 - day basis (1 year) using the program Origin 6.0. Microcal Origin 6.0, Microcal Software, Inc., 1991 – 1999). Correlation coefficients were calculated and diagrams were conceived by the help of statistical package STATISTICA ver.6, StatSoft Inc., 2001.

3. Results

Heart arrhythmias have been analyzed in regard to CRI, GMA and Solar Activity (SA). At first the correlation coefficients between GMA, SA and CRI parameters and the number of arrhythmias (Total and for each type separately on 1- year basis) were calculated. It is seen that there are significant correlation coefficients although small by value, especially for Total and V1 type of arrhythmias.

It is interesting that the primary and secondary maxima observed in the solar (Figs 1, 2) and geomagnetic parameters (Fig. 3) during the solar cycle 22, also appeared in several types of arrhythmias with a time lag of about five months. It is clearly seen (Figs 1, 2 and 3) a different behavior of the solar and geomagnetic parameters as well as the different types of arrhythmias before and after 1989 (or 1990 in some cases). This time period coincides with the polarity reversal of the solar magnetic field: N – to + January 1990 S + to – June 1991 [7].

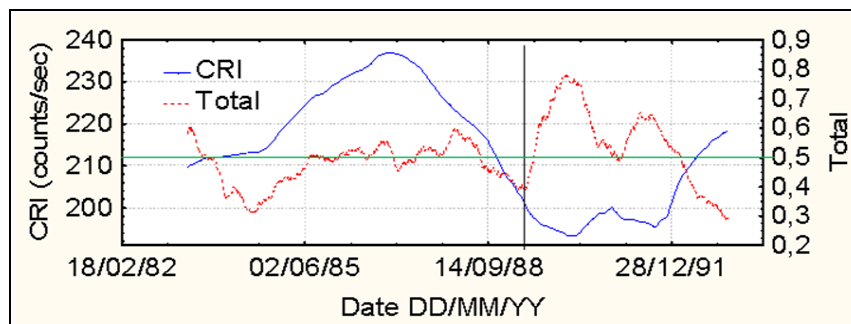


Figure 1. Variations of the total number of arrhythmias and CRI variations for the examined time period.

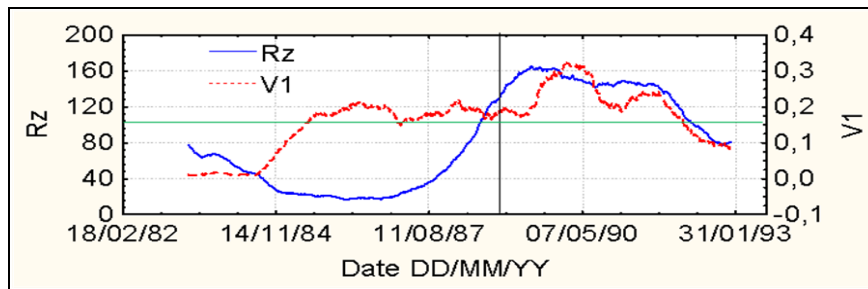


Figure 2. Variations of the number of V1 type of arrhythmia and Rz variations for the examined time period.

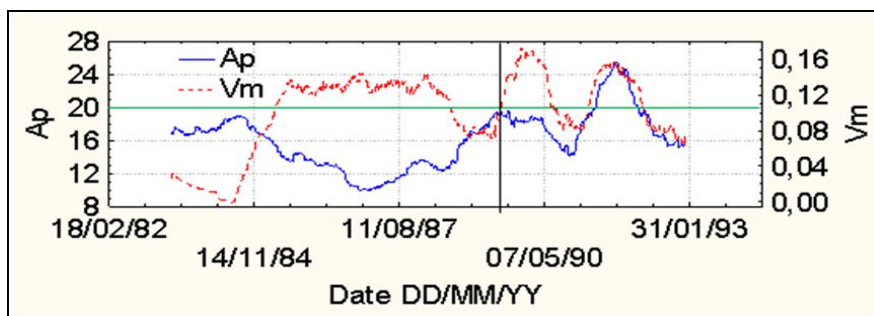


Figure 3. Variations of the number of Vm type of arrhythmia and Ap-index variations for the examined time period.

The parameters Rz (Fig. 2) and Ap (Fig. 3) are inversely correlated with V1 and Vm types of arrhythmia respectively before and positively correlated after 1989 -1990. (The reversal of correlation is marked with the black vertical line. The green horizontal line indicates the average number of arrhythmias). CRI shows the opposite behavior (positive correlation before and negative correlation after 1989-1990) as expected, since CRI and solar (and geomagnetic activity variations are not independent. Low CRI is related to strong GMA [8] and strong SA [9], [10], [11]. This time period (1989-1990) coincided with the polarity reversal of the solar magnetic field [7].

It is also interesting that the primary and secondary maxima observed in the solar parameters during the solar cycle 22, also appeared in several types of arrhythmias with a time lag of about five months.

The time interval under examination was separated into two different time periods from 1983 to 1988 and from 1989 to 1993 and the calculated correlation coefficients are presented in Table 1. Differences are observed in the sign and value of the correlation coefficients. Specifically, sign changes were observed only for Total, and Ventricular arrhythmias V1 and Vm. The values of the correlation coefficients are higher for each period separately than those calculated for the whole time interval (Table 1).

4. Conclusions

This study focuses on the possible relation between the polarity reversal of the solar magnetic field and the various types of arrhythmias. The most interesting results are:

Table 1. Correlation coefficients between GMA, SA and CRI parameters and the number of different types of arrhythmias for two different time periods from 1983 to 1988 and from 1989 to 1993

Type of arrhythmias	Rz	C Flares	M, X Flares	SPE	CRI counts/sec	Ap	Dst (nT)
Total (1983 -1988)	0.0097 p=0.659	-0.0780 p=0.000	-0.1522 p=0.000	-0.1819 p=0.000	0.4700* p=0.00	-0.6599* p=0.00	0.1426 p=0.000
Total (1989-1992)	0.6672* p=0.00	0.2425* p=0.00	0.3010* p=0.00	0.5228* p=0.00	-0.8875* p=0.00	0.3651* p=0.00	-0.4170* p=0.00
V1 (1983 - 1988)	-0.1115 p=0.000	-0.4995* p=0.00	-0.1469 p=0.000	-0.0803 p=0.000	0.7390* p=0.00	-0.8164* p=0.00	-0.2331* p=0.00
V1 (1989-1992)	0.8161* p=0.00	0.1593 p=0.000	0.4051* p=0.00	0.6481* p=0.00	-0.9254* p=0.00	0.2501* p=0.00	-0.4055* p=0.00
Vm (1983 - 1988)	-0.3143* p=0.00	-0.6394* p=0.00	-0.3795* p=0.00	-0.2636* p=0.00	0.8480* p=0.00	-0.8874* p=0.00	0.0027 p=0.901
Vm (1989-1992)	0.4631* p=0.00	0.1935 p=0.000	0.2965* p=0.00	0.5074* p=0.00	-0.7184* p=0.00	0.6410* p=0.00	-0.6558* p=0.00

- the primary and the secondary maxima observed in the solar parameters during the solar cycle 22, also appeared in Total, V1, Vm and Ps types of arrhythmias with a time lag of about five months
- changing of polarity sign of the solar magnetic field was found to affect the sign and value of correlation between the incidence of arrhythmias and solar and geomagnetic variations and cosmic ray intensity
- Ventricular arrhythmias (V1 and Vm) appear to be more sensitive to the changing of polarity sign of the solar magnetic field compared to Supraventricular arrhythmias (S, Ps)

Acknowledgements: The authors thank all the providers of the NMDB stations and the solar and interplanetary data. The authors from the University of Athens thank the Special Research Account for supporting the Cosmic Ray Research.

References

- [1] Dorman L I, Iucci N, Ptitsyna N G, Villaresi G 2001 *Proc 27th ICRC (Hamburg)* 3511
- [2] Dimitrova S 2008 *Proc. IAU Symposium* **257** 65
- [3] Papailiou M, Mavromichalaki H, Kudela K, Stetiaraova J, Dimitrova S, Giannaropoulou E 2011 *Astrophys. Space Sci. Trans.* **7** 373
- [4] Gigolashvili M, Ramishvili G, Janashia K, Tvildiani L, Pitiurishvili P 2010 *National Astronomical Observatory, Internal Report.*, <http://www.docstoc.com/docs/48038168>
- [5] Stoupel E 2006 *Indian Pacing and Electrophysiology Journal* **6** 49
- [6] Belov A, Garcia H, Kurt V, Mavromichalaki H, Gerontidou M 2005 *Solar Phys.* **229** 135
- [7] Mavromichalaki H, Belehaki A, Rafios X 1998 *Astron. Astrophys.* **330** 764
- [8] Belov A, Baisultanova L, Eroshenko E, Mavromichalaki H, Yanke V, Pchelkin V, Plainaki C, Mariatos G 2005 *J. Geophys. Res.* **110** AO9S20
- [9] Forbush S E 1958 *J. Geophys. Res.* **63** 651
- [10] Pomerantz M A and Duggal S P 1974 *Reviews of Geophysics* **12** 343
- [11] Perko J S and Fisk L A 1983 *J. Geophys. Res.* **88** 9033