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Discovering a solar periodicity by chance

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Abstract. This opening talk describes the history of the discovery of the solar Rieger periodicities

In 1973 the Solar Maximum Mission (SMM) was conceived to study solar flares during the maximum phase of cycle 21. To investigate the sun in a wide photon energy range, the satellite should also carry a γ-ray spectrometer. Ed Chupp (University. of New Hampshire), the principal investigator of this experiment, told me later, that he had a hard time to persuade the NASA representatives of the importance of the instrument. First of all, he needed foreign participation to get it funded. So, he took us as partners to continue a collaboration that commenced with OSO 7. On our side, funding was guaranteed by the Ministry of Forschung und Technologie only if someone of the institute should be in part of the data reduction of the γ-ray experiment. When I was asked to do the job, I accepted, because it was of interest also to work in the domain of high-energy astronomy, although I continued working in the Ion Cloud group, the nucleus of our institute. Particle acceleration, for example, is a topic in both fields of research. My colleagues of the High Energy Astrophysics group promised to assist me, so I could wait for the data to come. Because of technical problems the launch of SMM was delayed up to February 14, 1980, so that sunspot maximum (around Sept. 1979) could not be met. In due time sun dropped into a lull of activity, and screaming arose we missed sunspot maximum and now we get the pay back for not being ready in time. However, activity came back with a number of flares, part of them were also recorded by our spectrometer (Fig. 1). In this figure we see that, for almost half a year of recording, flares with γ-ray emission even beyond 10 MeV, are optically small events. This apparent anti correlation of optical importance and high photon energies was the more surprising, because in all papers and textbooks about solar flares one could read, that only exceptionally large flares, recorded in H-alpha, may also be accompanied by γ-rays. But our measurements showed something different! In order to check if this weird outcome, possibly a sensation, should continue, I plotted the flares versus time as shown, with special emphasis on the optical importance (color coded/grey-levels). But as time went on, more and more optically big γ-ray flares showed up. So, nature behaved as expected. Sensation had turned into triviality! I was obviously fooled by a statistical fluke of the sun, and/or by my ignorance as a newcomer in this field. Nevertheless, I went on with my plotting, because it was a good way to demonstrate the tremendous success of our experiment. When about two years of recording had passed I began to realize a 5 month cadence of episodes of high flare activity and reported this at the HINOTORI Symposium in Tokyo 1982. I made also predictions about flare bursts to come, that turned out to be correct. A Fourier power spectrum

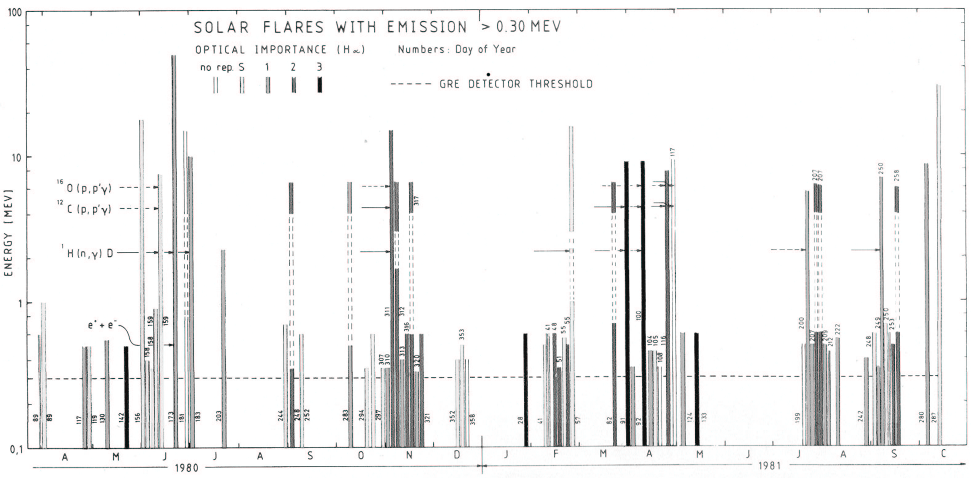

Fig. 1. Plot of solar flares with emission above 300 keV, the threshold of our spectrometer on SMM, covering the first 2 years of recording versus time. The upper end of the bars symbolizes the highest photon energy detected. The optical importance in H-alpha is color coded (grey levels). Numbers at the bars denote day of year. Horizontal arrows mark γ-ray lines (Annihilation line at 0.511 MeV; Neutron capture line at 2.223 MeV; Nuclear de-excitation lines of Carbon and Oxygen at 4.438 MeV and 6.129 MeV, respectively). (Reproduced from MPE Tätigkeitsbericht 1981)

brought clear evidence for a period at 154 days. In 1984 we then dared to submit a paper to Nature, which was accepted friendly (Rieger et al. 1984). There were already searches for solar periodicities in the midrange preceding SMM : Vitinskii (1960) analyzed the relative sunspot number and found fluctuations that ranged from 3 months to 1 year, with an average duration of about 5 months. Dodson and Hedeman (1970) investigated the sunspot number, 2800 MHz flux and calcium plages and detected that increases in solar activity generally occurred with a repetition period of 3-5 rotations or months. Charles Wolff of Goddard Space Flight Center analyzed the monthly mean sunspot number from 1749-1979 and found a multitude of periods from 2 months to about 2 years, including a periodicity at 155 days (Wolff 1983). But, curiously enough, it was primarily a chance discovery, that brought new life to this Solar domain and, due to activities of Maria Massi and colleagues, similar periodicities in another star were found (Massi et al. 2005).

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