The 154 day Solar cycle and related cycles

By Ray Tomes

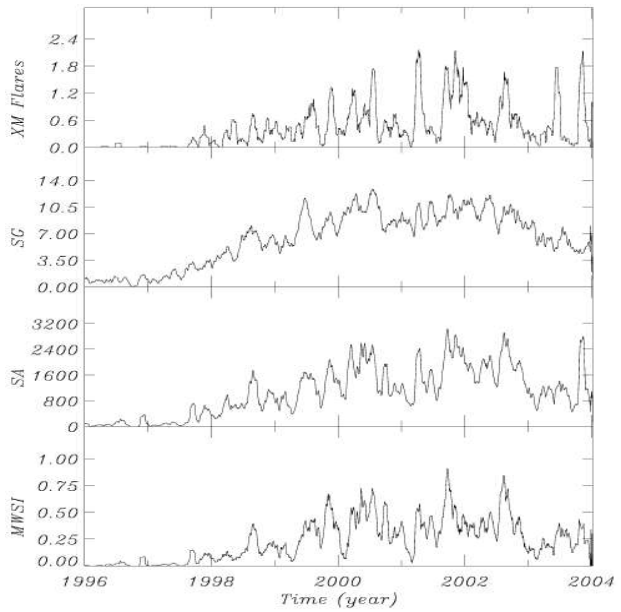
Solar variations of 154 days and related periods

The Sun has been found to have a 154 day cycle in gamma-ray flares, proton flares, solar wind, interplanetary magnetic field, sunspot areas and neutrino output. First reported in gamma ray flares in 1984 by Rieger et al, the cycle varies between 140 and 170 days and is most often reported as 154 or 155 days. The cycle is often associated with other cycles of periods near 28, 51, 78 and 103 days all of which are multiples of the solar rotation rate of 26 days (or 28 days as seen from the earth). Longer cycles of 1.28 and 2.14 years are also mentioned as associated, being 3 and 5 times the length of the 154 day cycle.

High energy Solar flares

Using daily data from the Solar Maximum Mission (SMM) and the Geosynchronous Operational Environmental Satellites (GOES), a 155+/-3 day cycle was found near the maximum of solar cycle 21. The period is often reported at solar maximum and tends to disappear at solar minimum. This may be due to using highly skewed data, and the author suggests reanalysis with log data being used instead.

J. L. Ballester, R. Oliver and M. Carbonell report that this period coincides in time with periodic emergence of magnetic flux in the form of strong magnetic fields, suggesting a causal relationship. Their figure is shown below.



Solar cycle 23. *From top to bottom*: 31 day boxcar average of the daily number of X and M solar flares; daily number of sunspot groups; daily sunspot area; daily MWSI.

Solar flux at 127 MHz

The mean flux density of the Sun has being monitored at Toruń since 1958 and G. Gawrońska and K.M. Borkowski carried out a search for periodicities in the Solar Flux at 127 MHz. They found the 11 year cycle but not the 154 day cycle. However other sub-harmonics of 25.8 days were found, including strong spectral peaks for 51.7 days is found 1958-1985, 103.3 days is present in cycles 20 and 21 especially 1969-1976 and 80.6 days up to 1989, especially just after ,maxima. Periods of 78 and 84 days were observed in radio flux at 10 cm, in sunspot areas and in flare activity by Bai and Sturrock.

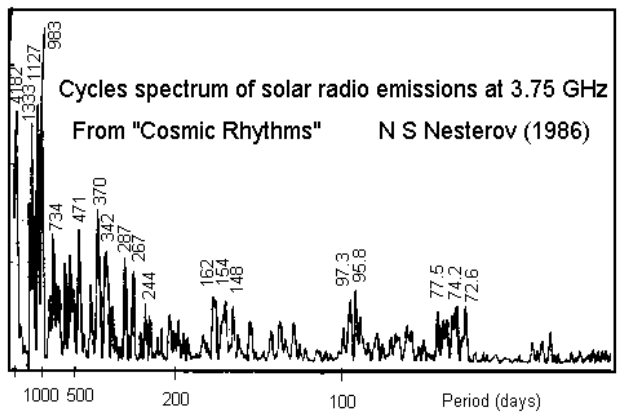
Solar neutrino flux cycles

Solar neutrinos do not come in a steady flux and so continue to surprise researchers. Because neutrinos can travel almost unimpeded from the Solar core where they are produced, to the Earth where we detect them, any variation in the flux of neutrinos must mean a variation in their rate of production. This suggests that the Sun has episodic bursts of activity in its core which is not something that was expected. Several novel ideas have been suggested to explain this fact.

Because light and heat from the Sun come to us from the Solar surface, they result from nuclear reactions that happened many thousands of years earlier. In that time, any short term fluctuations in the reaction rate would be smoothed out. Only the neutrino flux tells us what is actually happening in the Solar core right now.

The most noticeable variation in the flux is a 28 day period which matches the Solar rotation period as seen from the Earth. The actual rotation period of the Sun is 26 days, but because we are moving around the Sun, it takes an extra 2 days to catch up with the Earth's motion each rotation. Confirmation that the period is truly originating in the Sun is given by the presence of side bands. These side bands which result from the Earth passing north and south of the Solar equator once per year are found at 10.88, 11.88, 13.88 and 14.88 cycles per year in addition to the main peak at 12.88 cycles per year of the 28.4 day cycle.

Related cycles of 157 days and 780 days (2.14 years or quasi-biennial variation) were also found to be present weakly in the neutrino flux, but no 11 year cycle was found by the Stanford researchers reporting these results. The period of 780 days is five times 156 days, and has therefore been suggested as being harmonically related.



In "Cosmic Rhythms" (in Russian) N S Nesterov shows the above spectrum of fluctuations in 3.75 GHz solar radio emissions. The triplet centred on 154 days may be interpreted as a 154 day cycle amplitude modulated by periods of ~4.7 and ~9.4 years. Note also another triplet near 154/2 or 77 days which has modulations of 3.1, ~4.8 and ~9.2 years. These modulation periods are inaccurate due to the data being only for two solar cycles.

Modulations of cycles

N S Nesterov has reported the spectrum of Solar radio emissions at 3.75 GHz. As well as showing common periods of 154 and 77 days, there is complex spectral structure around each of these periods suggesting modulation by longer cycles. Generally reports indicate that the cycles are stronger near solar maximum, so these modulations may be due to the main 11 year solar cycle. The analysis is based on just 2 solar cycles, so the modulation periods will not be very accurate.

Harmonic Relationships in Solar cycles

N. A. Krivova and S. K. Solanki note that the power of a 1.28 year sunspot cycle period varies strongly over time but does vary approximately in phase with the 156 day Rieger period of Solar flares. This result based on wavelet analysis suggests that these two cycles are harmonics because 1.28 years is 3 times 156 days. They find that this period of 156 days continues into more recent cycles in contrast to earlier results.

They also report significant power at all multiples of 1.3 years (reported as 1.28 years above) up to 10.4 years. They note also that the 156 day period is found in sunspot numbers and that the 1.3 year period is found in variations of geomagnetic activity and interplanetary magnetic field.

Many researchers have noted the harmonic relationships in the solar periods. Bai and Sturrock comment that the 154 day and related periodicities are sub-harmonics of a fundamental period. When all the reports are combined it is even clearer that all the reported periods are harmonically related to each other. The solar cycle periods are observed in geophysical cycles on Earth and also harmonically related to other commonly observed cycles on earth from other disciplines. The following table has been produced with exact ratios of 2 and 3 to best fit all the known cycles periods.

It is clear that this produces another whole set of related cycles like Dewey's table of common cycles in the range of years. Furthermore, these cycle periods are related by being a factor of 7 smaller than Dewey's table.

Harmonic relationships in solar cycle periods
(all figures in days)

			464.2	
1238	619	309.5	**154.7**	**77.4**
		103.2	**51.6**	**25.8**

The periods are shown with exact harmonic ratios of 2 horizontally and 3 vertically in the same way that Dewey showed these relationships exist in many longer period common cycles. The six bold figures are representative of the reported solar flare cycles, except that, because of the Earth's motion around the Sun, 28 days is reported rather than 26 days.

The 1238 day cycle accurately matches Edward R. Dewey's determination of 40.68 months for the stock market cycle, while the 619 day cycle matches the author's determination of a 1.695 year cycle in wheat prices. This harmonic matching of seemingly unrelated cycles is a feature commonly reported by Edward R Dewey.

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