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Action conservation and the solar sunspot cycle

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By simple arguments, we reformulated the sunspot time-series to have an amplitude which can be argued to be approximately proportional to the magnetic flux density at the coronal surface. This new sunspot time-series reproduces the (average) 22 year solar cycle, in contrast to the approximate 11 year cycle found in the standard version of the sunspot series. The new version of the time series seems most relevant for studies addressing the magnetic field variation of the sun, which is known to have a cycle close to 22 years. The local amplitude-frequency variation of the revised sunspot series is investigated in detail by use of a wavelet transform. Closer scrutiny of the sunspot variation indicates that the local frequency of the solar cycle and the local energy in the magnetic field vary consistently with conservation of action, i.e. local energy divided by local frequency. In the present formulation of the sunspot analysis, the Maunder minimum will be conspicuous by being associated with a very low frequency and a very low magnetic energy, in such a way that the ratio of the two quantities will be close to what is found at other times. Our analysis is based on the available sunspot data beginning with the year 1700. The results relate to observations reported in the literature. The approximate action conservation in the revised time series indicate that the solar cycle is dominated by only few degrees of freedom.

Reference: Hans Pécseli and Jan Trulsen, On the possibility for action conservation in the solar cycle, Solar Physics **222**, 363-382 (2004).