Variability of solar coronal rotation and fractal dimension over the solar cycles using solar radio observations

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Abstract:

In this investigation, solar radio fluxes at two frequencies 2695 MHz and 4995 MHz observed at Learmonth Observatory, Australia for the period from 1988 to 2009 (covering nearly two solar cycles) is used. Using flux modulation method, we estimated coronal sidereal rotation period of the Sun for the aforementioned period. According to model of Aschwanden & Benz (1995), the radio emissions at 2695 MHz and 4995 MHz would be produced at heights ~ 12000 Km and ~ 7000 Km above the photosphere, respectively. Thus, our estimates provide a tool to learn about the coronal rotation and fractal dimension at two altitudes in the solar corona. The rotation periods are estimated by the fitting of Gaussian curve to the first secondary maxima of autocorrelogram of each year. This would be synodic rotation period which is converted to sidereal rotation period by correcting for Earth's rotation around the Sun. The comparison of results indicates dissimilar trends at both the heights in solar corona. The detailed comparison of sidereal rotation periods of these show close resemblances in some years where as there are differences in the estimated sidereal rotation periods as much as one day. The temporal variation of sidereal rotation period seems to suggest presence of Hale cycle (22 years) in 2695 MHz while 4995 MHz do not suggest any resemblance with solar activity cycle during the period of study. The polynomial fit is fitted for sidereal rotation period of solar radio flux at 2695 MHz as function of year. The value of Pearson's coefficient for polynomial fit is ~ 0.7. The fractal dimension is a measure of randomness and the results of fractal dimension show close resemblance with sunspot number as well as 11 year solar activity cycle. The Pearson's coefficient for fractal dimension of solar radio flux at 2695 MHz and 4995 MHz with the sunspot number is 0.877 and 0.857, respectively, which indicates a significant correlation between these parameters.