Discovery of 795 New Maunder Minimum Candidates in Kepler Data Using a Novel Autocorrelation Function

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This project analyzes data from Kepler Mission and LAMOST observatory to identify stars currently in a Maunder Minimum (MM) phase, an extended period of low sunspot activity, coincidental with the Little Ice Age, and develops criteria for their selection. Using light curve data from 3339 G-type stars (magnitude < 13.0, log G > 4.0) selected from the Kepler Stellar Table, the study applied an autocorrelation function combined with the Lomb-Scargle (LS) periodogram to detect dominant rotation periods and their corresponding LS powers. Stars with LS powers below the simulated noise thresholds were classified as low activity, indicating unobservable sunspots. Sensitivity tests confirmed that this method could detect sunspots with brightness variations as small as 8.65 ppm (equivalent to 0.36 Earth radii for a Sun-like star) and it could also detect sunspots for stars with wide range of inclinations (from 3° to 90°) based on an analysis of 212 samples with identified inclination data. The derived rotation periods were compared against stellar metallicity, chromospheric activity index (logR'K), and 48-hour flux root-mean-square (RMS) variability to explore correlations between magnetic activity, flux variability, and observable rotation periods. An overwhelming flux RMS divergence between active and inactive stars was confirmed via a double T-test. The study identified 795 potential MM candidates and found that stars with (logR'HK = -4.404-0.285[Fe/H]) are likely magnetically inactive, indicating insufficient activity to sustain sunspots. Furthermore, stars exhibiting flux RMS < 51.90 ppm were classified as highly probable MM candidates, suggesting that combined photometric and spectroscopic criteria can effectively distinguish low-activity solar analogs.

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