The Evolution of Sun-Like Stars, as Revealed Through Kepler Light Curves

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Abstract

The photometric behavior of Sun-like stars – from long-timescale variations attributed to the rotational modulation of spots to high-frequency acoustic oscillations – changes as stars spin down on the main-sequence and then as they evolve to become subgiants and red giants. Using Kepler long-cadence light curves, we present a unified picture of how the photometric variability of Sun-like stars on hours to days timescales evolves with time. We find that stars exhibit clear evolutionary sequences in a diagram of three simple photometric variability measures, thereby providing a stellar evolutionary diagram involving only simple measures of photometric variations. We observe that the light curves of these stars become "quieter" as the stellar spot coverage decreases with time, but that they become suddenly and significantly more complex as stars approach their evolution off the main-sequence and spots no longer dominate the brightness variations. Using an asteroseismically analyzed sample of stars, we demonstrate that the sequences in our diagram are a strong function of stellar surface gravity, yielding a simple tool to accurately measure this quantity to better than 0.1 dex with just the long-cadence light curve. The Sun also obeys these newly found relationships: we correctly recover its surface gravity to within 0.1 dex with just our simple measures of photometric variability. We suggest that the brightness variations we observe trace granulation but manifested in a remarkably simpler fashion than previously appreciated.

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