Thomas Metcalf SPD Travel Award Report for Ricky Egeland*

From the IAU Symposium 328 "Living around active stars"

Maresias, Brazil, October 17–21, 2016

Left to right: José Dias do Nascimento, Jr., Gustavo Porto de Mello, Jorgé Meléndez, and Ricky Egeland at the IAUS 328.

Thanks to the Thomas Metcalf travel award I was able to attend IAUS 328 in Maresias, Brazil and present my oral contribution "Evolution of Chromospheric Activity in Solar Analogs". This work is focused at understanding the 11-year solar activity cycle in the context of the Sun-like stars. Our "solar analog" sample contains 27 stars with color index $B-V$ ranging from 0.59 to 0.69, which are within roughly 10% of the solar mass. These stars have synoptic observations in both the iconic Mount Wilson Observatory (MWO) HK Project (1966–2003) and the Lowell Observatory Solar Stellar Spectrograph (SSS; 1994–present), which observed the Ca II H & K lines that are a proven proxy for magnetic flux on the Sun. By cross-calibrating these data, we have made composite Ca II HK S-index time series of nearly 50 years in length for the majority of the sample, allowing us to examine long-term variability on longer timescales than previously possible.

The sample has been accurately characterized with effective temperatures and metalicities from the Geneva–Copenhagen Survey, as well as *Hipparcos* parallaxes. We have collected rotation measurements from the literature and find that rotation is evenly sampled for rotation periods $P_{\rm rot}$ from 4–20 days, with sparser sampling for slower rotations out to a maximum of 29 days. We find that the amplitude of variability is strongly dependent on rotation period, with those stars having $P_{\rm rot} < 9$ days with an amplitude of variability 4-5 times the solar cycle. We used the precise visible-band differential photometry of the Fairborn Observatory APT survey to show that the active stars vary by up to 2–3% in the Strömgren b and y bandpasses. This is compared to the significantly weaker $\sim$0.1% total solar irradiance variability measured for the Sun. Planets orbiting these highly variable stars will have climates and weather patterns that are significantly coupled to the conditions on their host star, impacting habitability. We searched our sample for cycles similar to the Sun's using a new cycle quality metric based on the amplitude spectral density of the Lomb-Scargle periodogram. Notably, we find that clear monoperiodic cycles are rare in this sample, possibly indicating that the dynamo of the Sun is unusual for G-type stars.

Attending this conference was a great opportunity to meet with Brazilian researchers Jorgé Meléndez, José Dias do Nascimento Jr., and Gustavo Porto de Mello, all who work with observations of solar twins. We had many fruitful discussions, and in particular it was useful to learn that Meléndez' student, Fabrício C. Freitas, found from HARPS observations of bright asteroids that the Solar S-index has been overestimated in the literature. This is in agreement with my recently submitted article on the S-index of the Sun using unpublished observations of the Moon from the MWO HKP-2 instrument.

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