Using solar twins to study the past and future of the Sun

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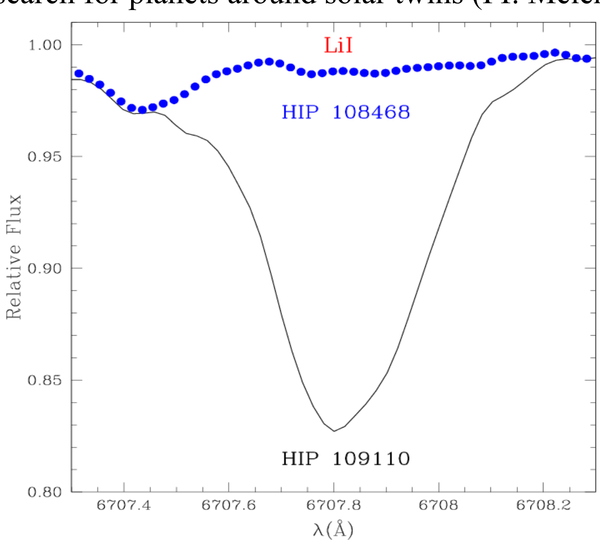
Science case. Since we can observe the Sun only at its current age, we have to rely upon younger and older stars to understand how the Sun would have been or how it will be at different evolutionary stages. The ideal sample of stars to compare the Sun with are solar twins *(Cayrel de Strobel 1996, A&A Rev. 7, 243)*. These stars have spectra very similar to the Sun's *(e.g., Datson et al. 2014, MNRAS 439, 1028)*, hence they have similar atmospheric parameters (effective temperature, surface gravity, metallicity) and about the same mass and chemical composition *(e.g., Meléndez et al. 2012, A&A, 543, A29)*. Having a mass and composition similar to the Sun ensures that solar twins will follow about the same evolutionary path as the Sun, allowing thus to study the evolution of the Sun in time.

Our aim is to use solar twins available in different K2 fields to study the evolution of key fundamental properties of the Sun. In particular, we will determine the rotation period of solar twins spanning a range of ages, to prove the spindown of the Sun. This will be useful to assess whether the Sun is a typical rotator. As stellar interior models are tested using the Sun, it is urgent to determine whether the Sun is a typical star or not. The time series will be also important to study short term variability of one-solar-mass stars as a function of age, which could be critical for the development of technologically advanced civilizations. If a white-light flare as bright as that witnessed by *Carrington (1859 MNRAS 20, 13)* were to happen today, it would surely cause huge disruptions to communications on our planet. Fortunately, such gargantuan flares are expected to be rare (about once or twice per millennium), but they could have been more frequent for the younger Sun. Although long cadence would be enough to determine the stellar rotation period, short cadence is required to study short term stellar variability (Carrington's white-light flare lasted only a few minutes). Furthermore, short cadence is important to constrain the mass and age of the star through a seismic analysis. This will be done in collaboration with Dr. M. Bazot. We have an on-going collaboration to perform the asteroseismic modeling of the solar twin *18 Sco (Bazot et al. 2011 A&A 526, L4)*. We will be able to verify, using stellar oscillations, the mass and age determined through isochrones. The seismic modeling will be complemented with high precision chemical abundances and atmospheric parameters that can be obtained in solar twins, through a differential spectroscopic analysis relative to the Sun *(Melendez et al. 2009 ApJ 704, L66)*.

Target selection. Solar twins are rare. Fortunately, one is available in the campaign 3 field. This solar twin, HIP 108468 (206078331), has an isochrone age ~7,5 Gyr, so about 3 Gyr older than the Sun. The lithium feature in this star is very weak (see figure below) and it has a low activity, reinforcing thus an old age *(e.g., Monroe, Meléndez, Ramírez et al. 2013 ApJ 774, L32)*. Hence, this solar twin can shed light on the long-term evolution of the Sun. It is included in our ongoing HARPS Large Program to search for planets around solar twins (PI: Meléndez), thus we will have also constraints on planets.



The spectrum of our K2 target, the solar twin HIP 108468 (206078331), is shown by filled circles around the 6707.8Å lithium feature. This old (7.5 Gyr) solar twin has a much weaker Li absorption than the young (~ 1 Gyr) solar twin HIP 109110 (206475442), shown by a solid line.