A Flexible Model for Investigating Properties of Starspots

Model Validation

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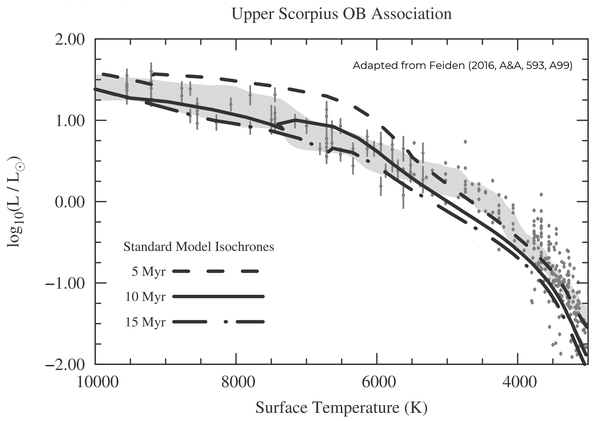
Context

Stellar evolution models of cool young stars routinely fail to reproduce the observed properties of real stars, jeopardizing the validity of model-derived stellar ages and masses.[1,2]



Starspots have emerged as a leading explanation for the anomalous properties of cool young stars.[3] It's assumed that stars inflate and become cooler due to the presence of spots.[4] However, there is little evidence to suggest this must necessarily be true.

What are we doing about it?

We developed a simple phenomenological model to incorporate starspots into stellar model predictions without making these assumptions [**POSTER 125**]:

$$\zeta = \xi\varphi^4 \left[1 - \varrho\left(1 - \varpi^4\right)\right]$$

Luminosity ratio | Surface area ratio | Photospheric temperature ratio | Spot areal coverage | Spot temperature contrast

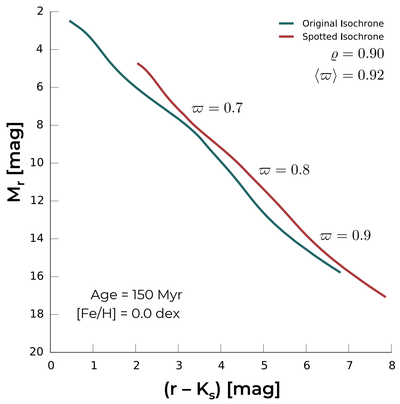
We're applying this model to color-magnitude diagrams of young clusters to extract best-fit properties for the spots **and** their impact on stellar structure. [**POSTER 10**]

When and how much should we trust our results?

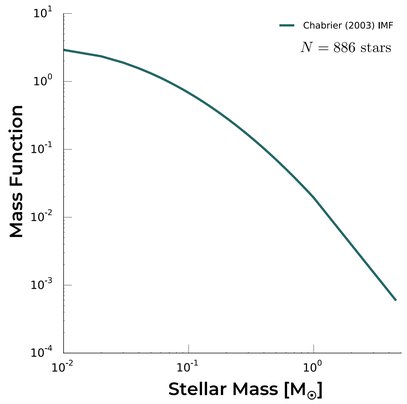
Creating synthetic clusters

To test the viability of our approach, we created 1500 synthetic stellar clusters with random ages, richness, and spot properties (temperature contrast and surface coverage) using two different physical assumptions.

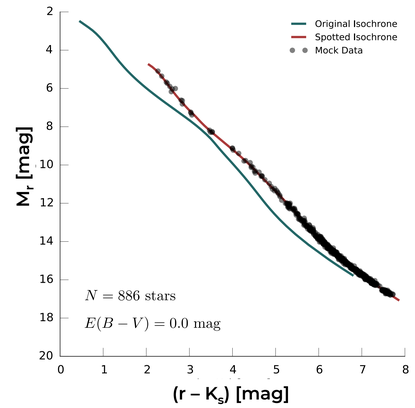
Step 1: Add Spots to Isochrone



Step 2: Populate the CMD

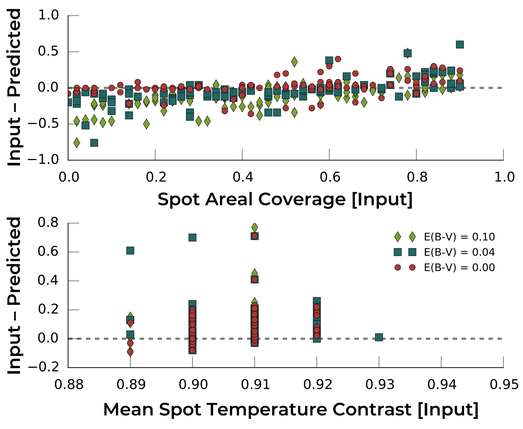


Step 3: Add Scatter / Reddening

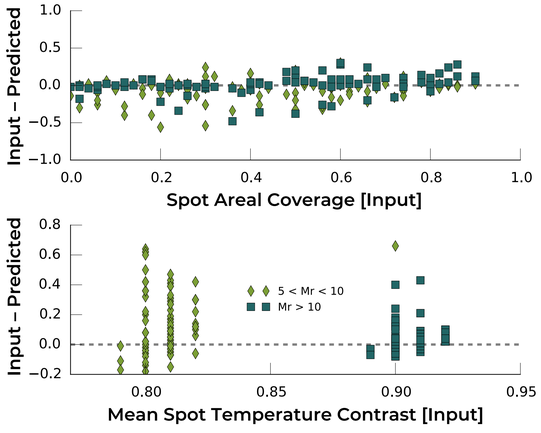


How well can we recover starspot properties?

single isochrone fit



two isochrone fit



key results

We typically recover spot surface coverage to within 5% - 10%, except when surface coverage > 80%.

We recover correct physical assumptions (i.e., how spots affect stellar structure) in 40 – 50% of tests.

Recovering temperature contrasts is more difficult, but may not be as bad as we think... ask me why!

The accuracy of our recovery appears independent of cluster age and cluster richness. Recovery of input parameters will improve as we add constraints from multiple different CMDs.

Want to learn more?

Check out **Poster 10** and **Poster 125**, authored by outstanding **UNG 2nd Year Undergraduates.**

And/or read these papers (we did): [1] Herczeg & Hillenbrand (2015, ApJ, 808, 23), [2] Naylor (2009, MNRAS, 399, 432), [3] Somers & Pinsonneault (2015, MNRAS, 449, 4131), [4] Spruit (1982, A&A, 108, 348)