Rotation and Spot Activity of Young Solar-Type Stars

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Spot activity study

- Recent study of 21 nearby solar-type stars
- 16 – 27 years of nightly photometry from Fairborn
- Spectral types F9 – K4
Differential Rotation

- DR results agree roughly with flat $\Delta \Omega$ vs. $\Omega$ dependence.
- No temperature dependence at $4500 \text{ K} < T_{\text{eff}} < 6000 \text{ K}$.

(cf. Küker & Rüdiger 2011, Reinhold et al. 2013)

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>$\nu$</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.76</td>
<td>0.24</td>
<td>Henry et al. (1995)</td>
</tr>
<tr>
<td>0.3</td>
<td>0.7</td>
<td>Donahue et al. (1996)</td>
</tr>
<tr>
<td>0.85</td>
<td>0.15</td>
<td>Barnes et al. (2005)</td>
</tr>
<tr>
<td>0.71</td>
<td>0.29</td>
<td>Reinhold &amp; Gizon (2015)</td>
</tr>
<tr>
<td>1.36</td>
<td>−0.36</td>
<td>Lehtinen et al. (2016)</td>
</tr>
</tbody>
</table>

$k \propto P^{\mu}$

$\Delta \Omega \propto \Omega^{\nu}$
Activity cycles ($M, A$) and active longitudes ($t_{\text{min}}$) are both common on the studied stars.
Cycle lengths fall on a sequence of activity branches against the Rossby number and $\log R'_{HK}$ (cf. Saar & Brandenburg 1999). A new separation into sub-branches is seen with $\frac{P_{cyc,\, long}}{P_{cyc,\, short}} \approx 6$. 

reference data from Saar & Brandenburg (1999), Oláh et al. (2000, 2009)
Often the active longitudes have significantly shorter rotation periods than the mean spot rotation, $P_{\text{al}} < P_{\text{rot}}$. 

- **V889 Her**
  - $P_{\text{al}} = 1.33692$ d
  - $P_{\text{rot}} = 1.3454$ d
The period difference $P_{\text{al}} \neq P_{\text{rot}}$ is also observed on RS CVn binaries.

II Peg (Hackman et al. 2011)
Persistent active longitude migration may be explained by an azimuthal dynamo wave.

Or alternatively a deeper anchoring depth plus radial differential rotation.

Cole et al. (2014), poster 239
Active Longitudes

- Active longitudes appear limited to stars with roughly $\log R'_{\text{HK}} > -4.46$.

- A transition between axisymmetric and non-axisymmetric dynamo modes?

![Graph showing relationship between rotation and spot activity of young solar-type stars.](image)
Come meet us at posters

152 – Rotation and spot activity of young solar-type stars (Lehtinen)
239 – Azimuthal dynamo waves in theory and observation (Cole)