Gyrochronology in the Era of Wide-field, High-cadence, Synoptic Photometric Surveys

Establishing the Membership and Ages of Galactic Open Clusters.

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Measuring Photometric Rotation Periods: The Galilean Way

The Early Years

- Single Objects
- 10-14 night cadence
- Photoelectric photometers, single filter
- Narrow Field (arcsecond-arcminute)

Modern Era

- Multi-object (10s-100s objects)
- 4-6 weeks cadence
- Some mosaic CCD cameras, multi-filter
- Generally, wide-field (10-60 arcminutes)
- Small-aperture ESP transit cameras can provide VERY wide-field, high cadence, multi-year observations.

New/Next Generation

- Entire populations (10^5-10^8 stars)
- Multi-year cadence
- Giga-pixel CCD mosaic imagers
- Very wide field (2~5 degrees)
- DECam → deep, wide, low-masses
The Dark Energy Survey:
Observing Strategy – bad news for gyrochronology?

- Sept-Feb observing seasons
- 80-100 sec exposures
- 2 filters per pointing (typically)
  - gr in dark time
  - izy in bright/grey time
- Photometric calibration: overlap tilings, standard stars, spectrophotometric calibration system, preCAM
- 2 survey tilings/filter/year
- Interleave 5-10 SN fields in griz if non-photometric or bad seeing or time gap (aim for ~5 day cadence)
- DES is *probably* not going to enable substantial rotation period studies of *young* star clusters on its own.
  However, adding in NOAO community time will allow for period-finding to be achieved.
The Future of Gyrochronology: Synoptic Surveys:

What is gyrochronology?

- Using rotation periods to determine the age of a star.
- Distance independent method: advantage over traditional isochrone-fitting method and modern lithium depletion boundary method.
- Identification of stars in a period-colour diagram yields internal structure.
- Works especially well in open clusters:
  - Comparison with isochrones and LDB results can provide a statistically robust, distance-independent test of MS-models
- Caveat emptor: binarity and differential rotation can cause problems.
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Synoptic Surveys: Pros and Cons for Gyrochronology using DECam

Pros:
- Long baselines (>5 yrs)
- Deep: low-mass star periods
- Multiple Filters: Prot. confirmation
- People Friendly: data-pipelines, observing

Cons:
- Spot Lifetimes
- Period Evolution: (year-to-year)
- Deep: “high mass” saturation for nearby clusters.
- Deep: Source Confusion
DECam Gyrochronology Studies: Photometric Variables and Cluster Membership

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17 Open clusters in main survey fields

<table>
<thead>
<tr>
<th>Name</th>
<th>RA</th>
<th>Dec</th>
<th>#OCs</th>
<th>Name</th>
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<tr>
<td>SPT</td>
<td>-60&lt;RA&lt;105</td>
<td>-65&lt;Dec&lt;-30</td>
<td>16</td>
<td>7 NGC clusters, 7 ESO clusters</td>
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<td>-30&lt;RA&lt;30</td>
<td>-30&lt;Dec&lt;-25</td>
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<td>-30&lt;Dec&lt;-1</td>
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<td>(-Whiting 1)</td>
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<td>-50&lt;RA&lt;55</td>
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**Diagram:**

```
  μ_RA (mas/yr)  50
    -25  0  25
```

```
  μ_DEC (mas/yr)  25
    -50 -25  0
```