Stellar Rotation at Young Ages: Results from Corot's Monitoring of NGC 2264

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Stellar rotation

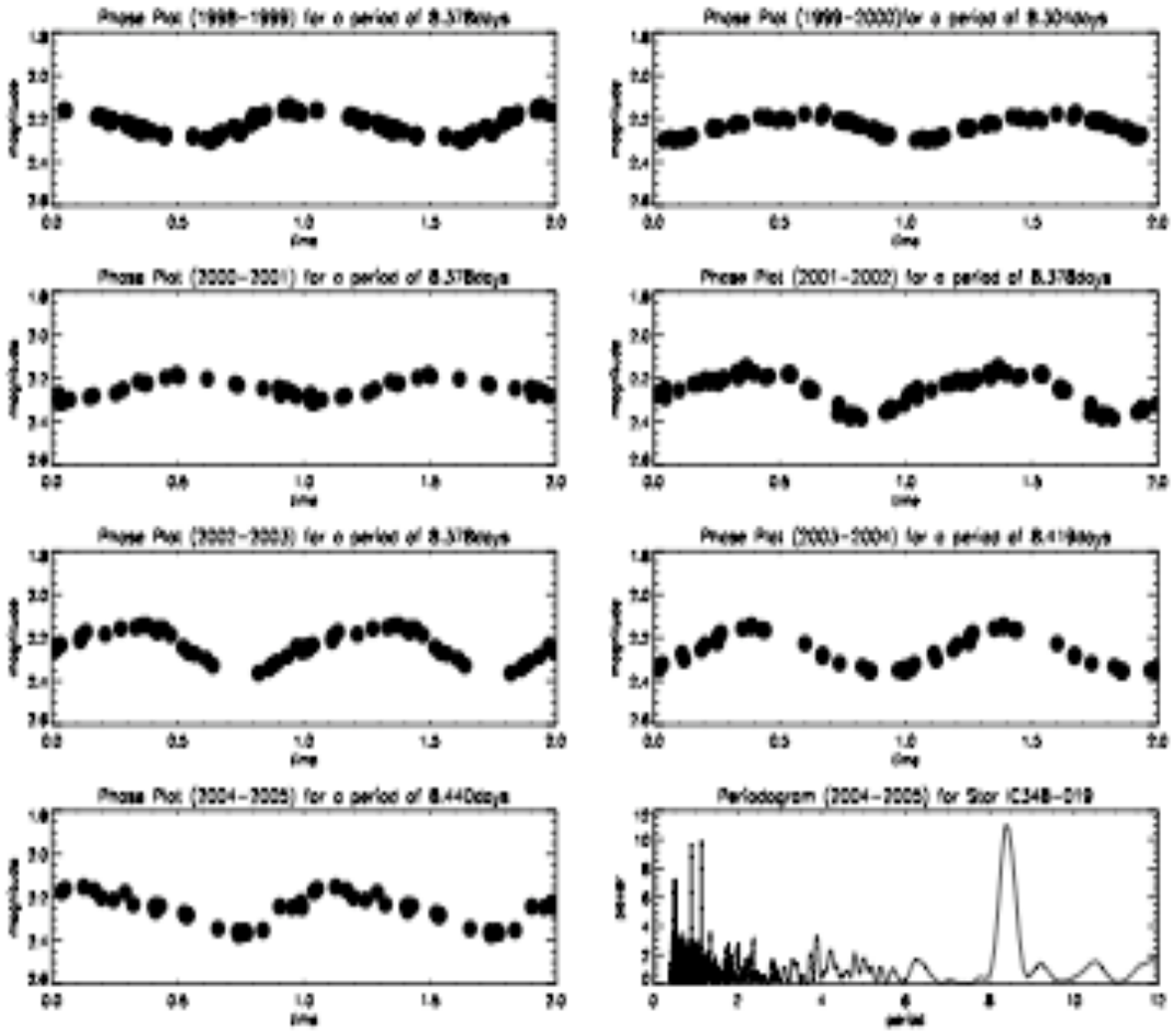
- Angular momentum evolution key parameter in star formation
  - From collapse of parent cloud …
  - … to contraction of YSO …
    - Factor 10^5-10^6 loss in J
  - … to evolution of the disk …
  - … to main sequence evolution
    - Further factor 10^2-10^3 loss in J

Stellar rotation

- J cannot be determined directly
- Surface rotational velocity (with radius) only possible proxy
- How to?
  - Photometric monitoring (real rotation periods)
  - Rotational velocities ($v \sin i$)

Photometric monitoring

- Perhaps oldest astrophysical technique!
  - Galileo's determination of the Sun's rotation…



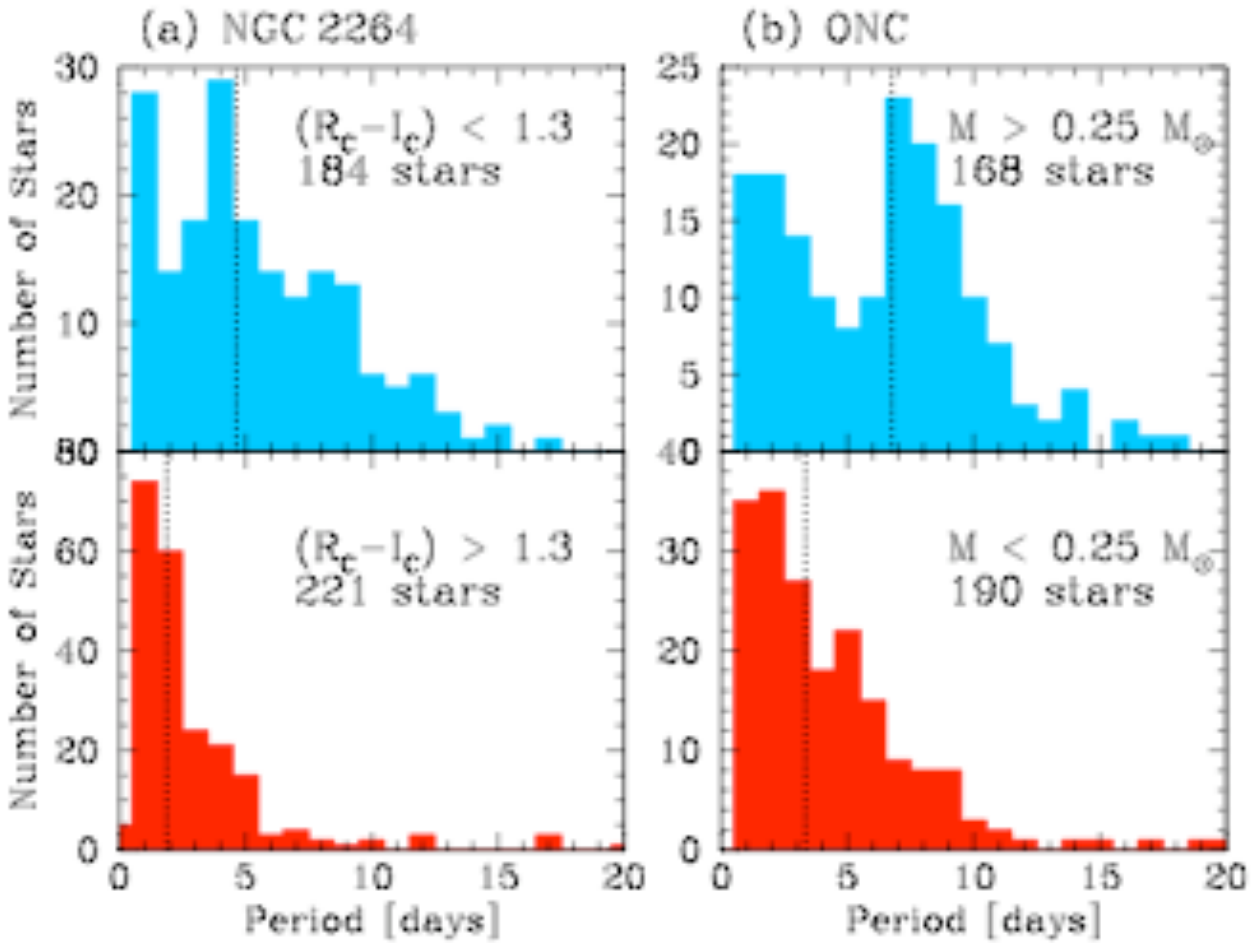
Ground-based "state of art"

- Close to 2000 stars in young clusters with photometric rotation periods
- Claimed accuracy ≈1%
  - High accuracy measurement
- Range of ages covered, from ONC to ZAMS
- Bimodal distribution for $M \geq 0.4\ M_{\odot}$
  - See e.g. Herbst et al.(2006) for recent review

Ground-based state of art

From Lamm et al. (2004)
ONC ≈1 Myr
NGC 2264 ≈3 Myr

Time ←



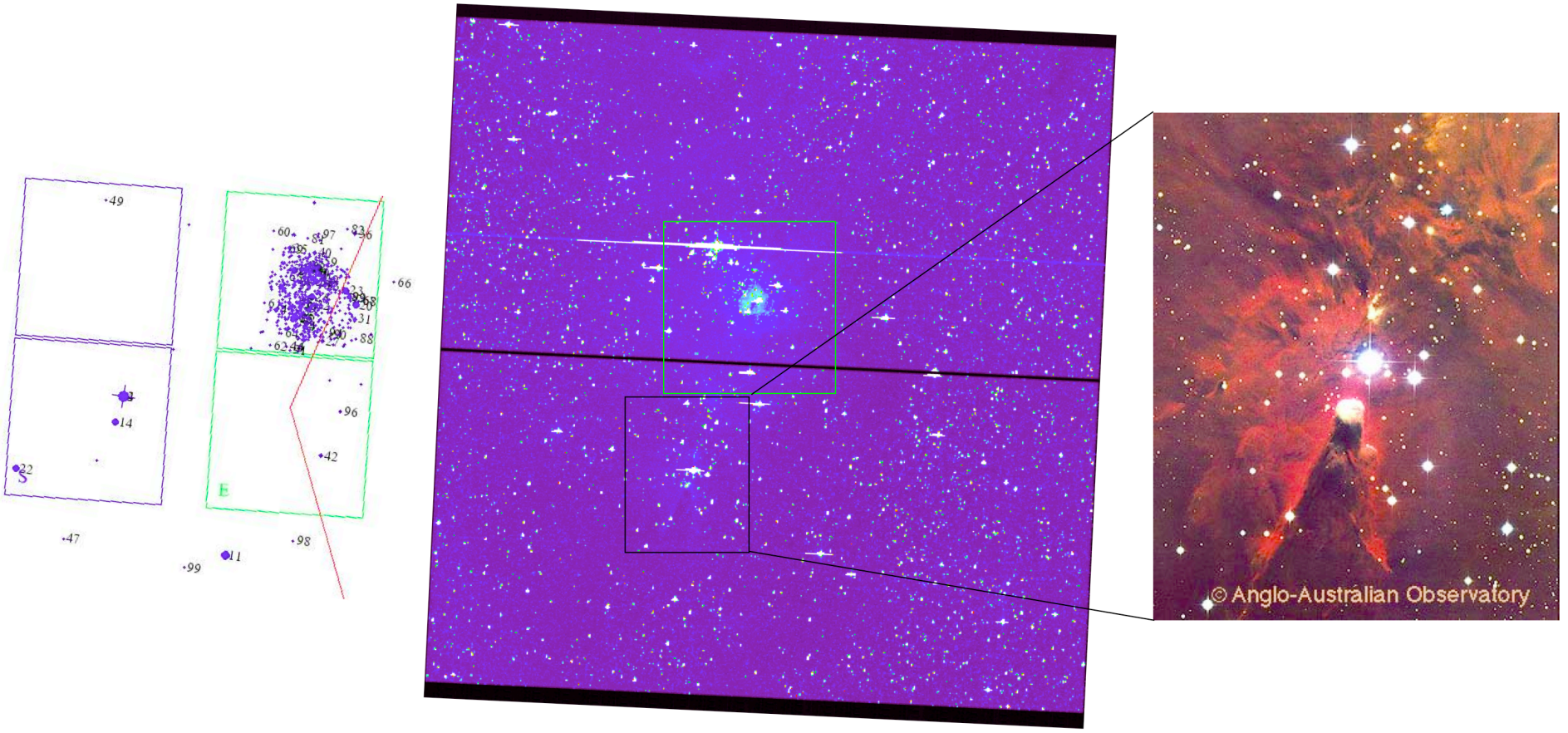
Corot and NGC 2264: an unique opportunity

- NGC 2264: only nearby SFR accessible to Corot
  - Corot allows uninterrupted, long-term phometric monitoring
- Well studied SFR
  - Optical (photo, spectro), IR, X-ray data available
- Ideal conditions thanks to dark cloud in the back of cluster

NGC 2264: key characteristics

- Distance ca. 760 pc
- Age: median 3 Myr (up to 5 Myr dispersion)
- Rich population of accreting and non-accreting stars across the HR diagram
- Ongoing star-formation

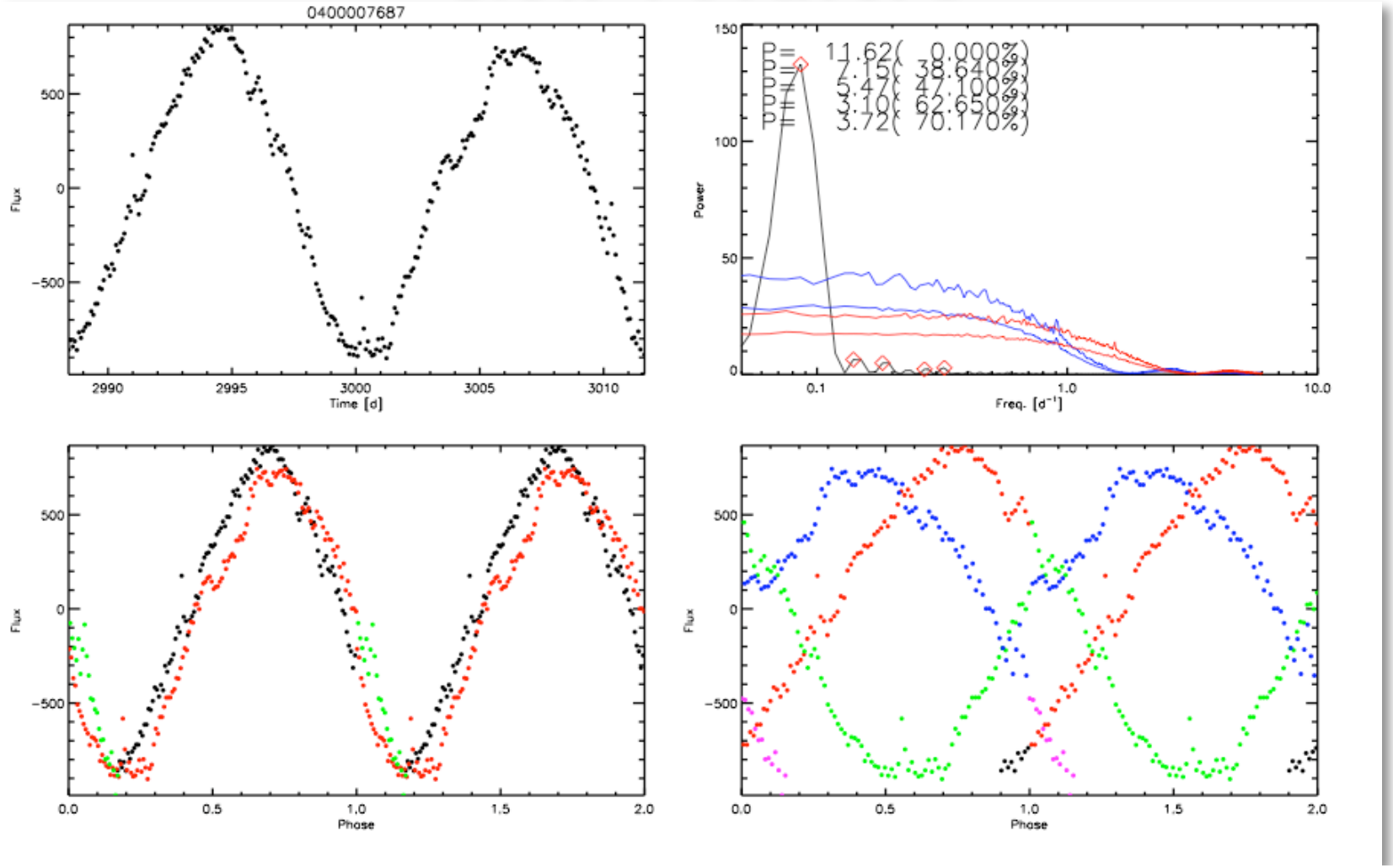
The Corot observation of NGC 2264 the pretty picture



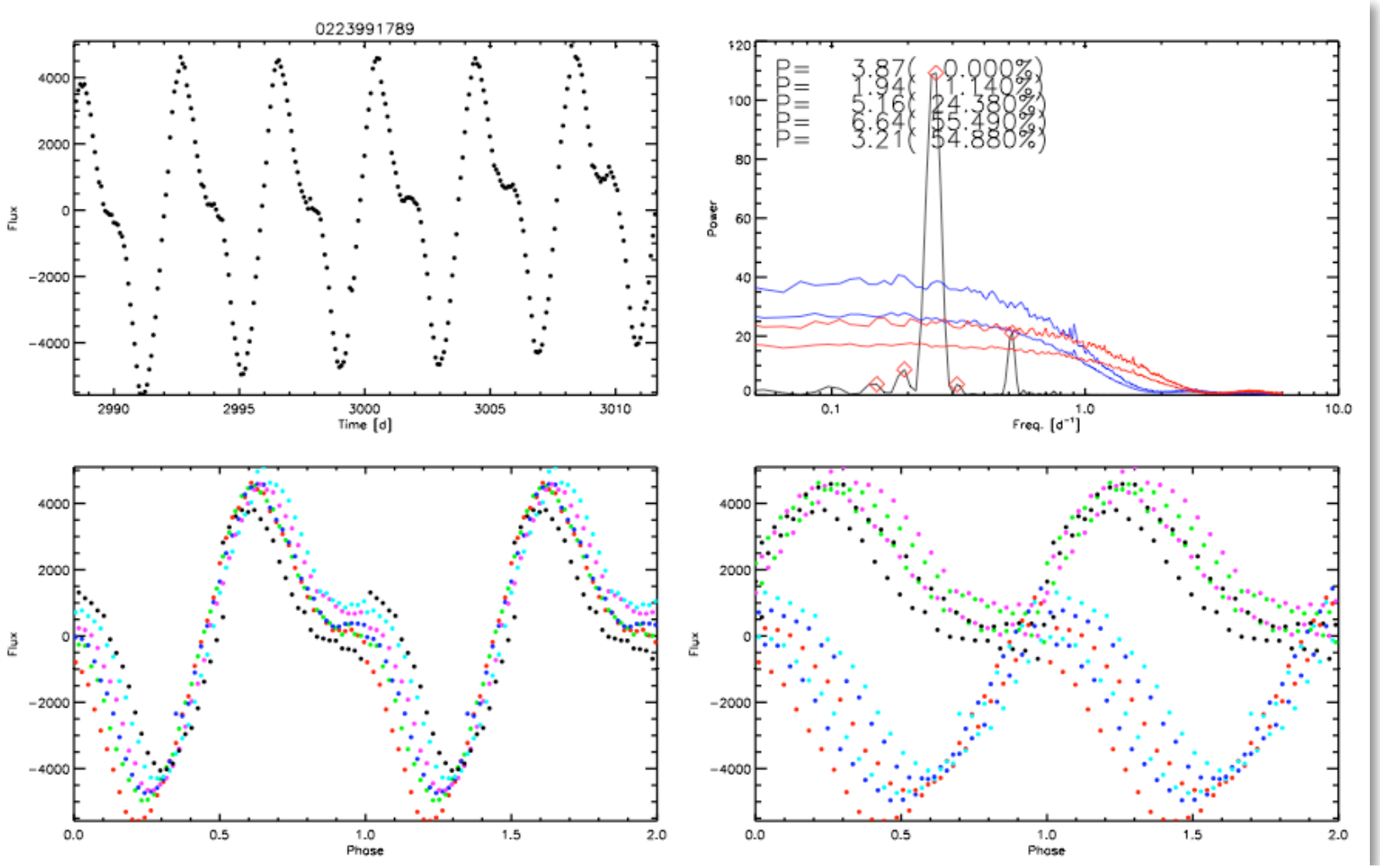
The Corot observation of NGC 2264

- 23.4 days duration, uninterrupted
- Near photon noise limited photometric accuracy
  - 27 cm diameter telescope
- Very wide FOV
  - Includes whole cluster plus many field stars
- 346 known cluster members observed
  - All types of YSOs (CTTS, WTTS)

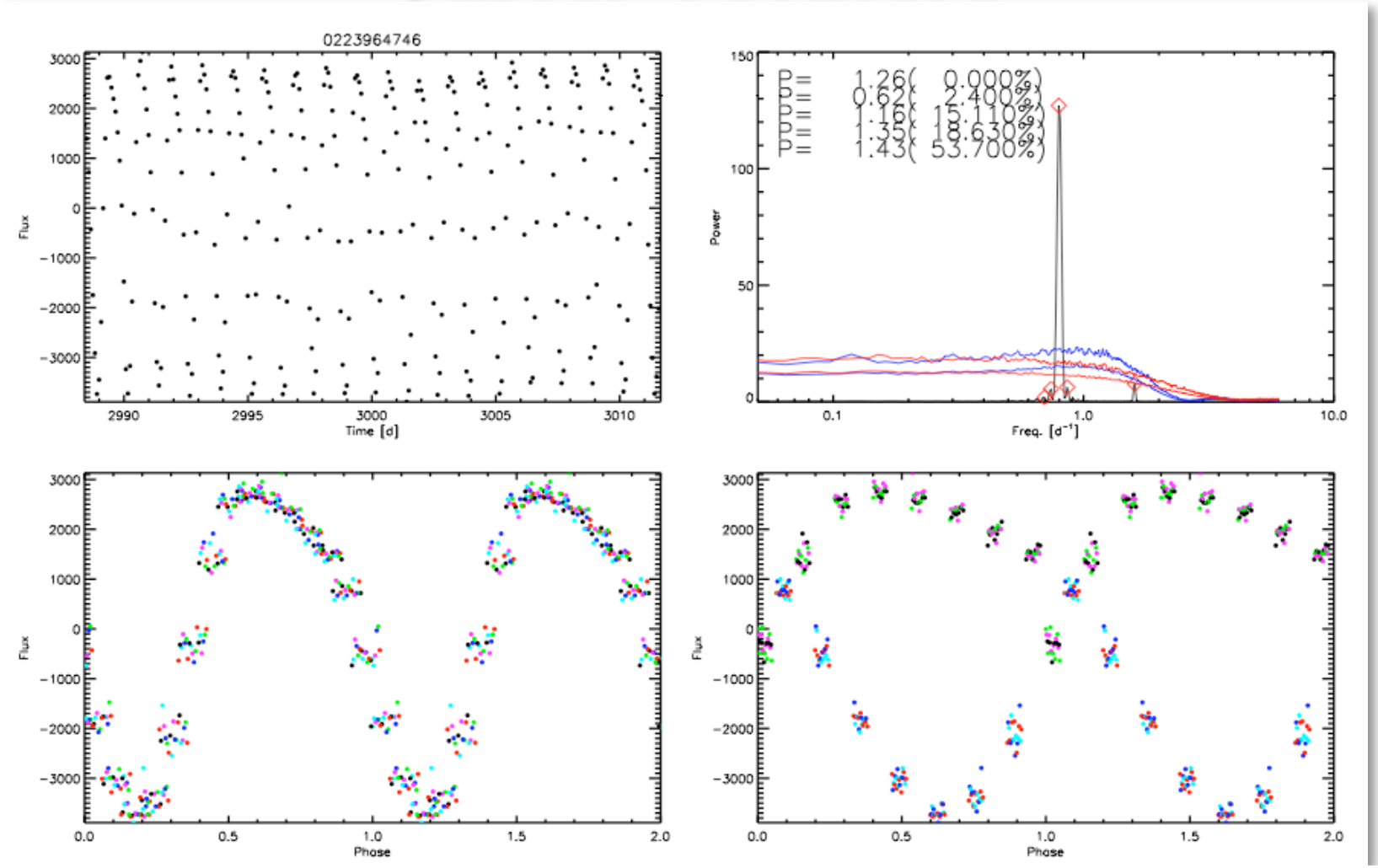
Rotational modulation in NGC 2264 stars from Corot data – slow rotators



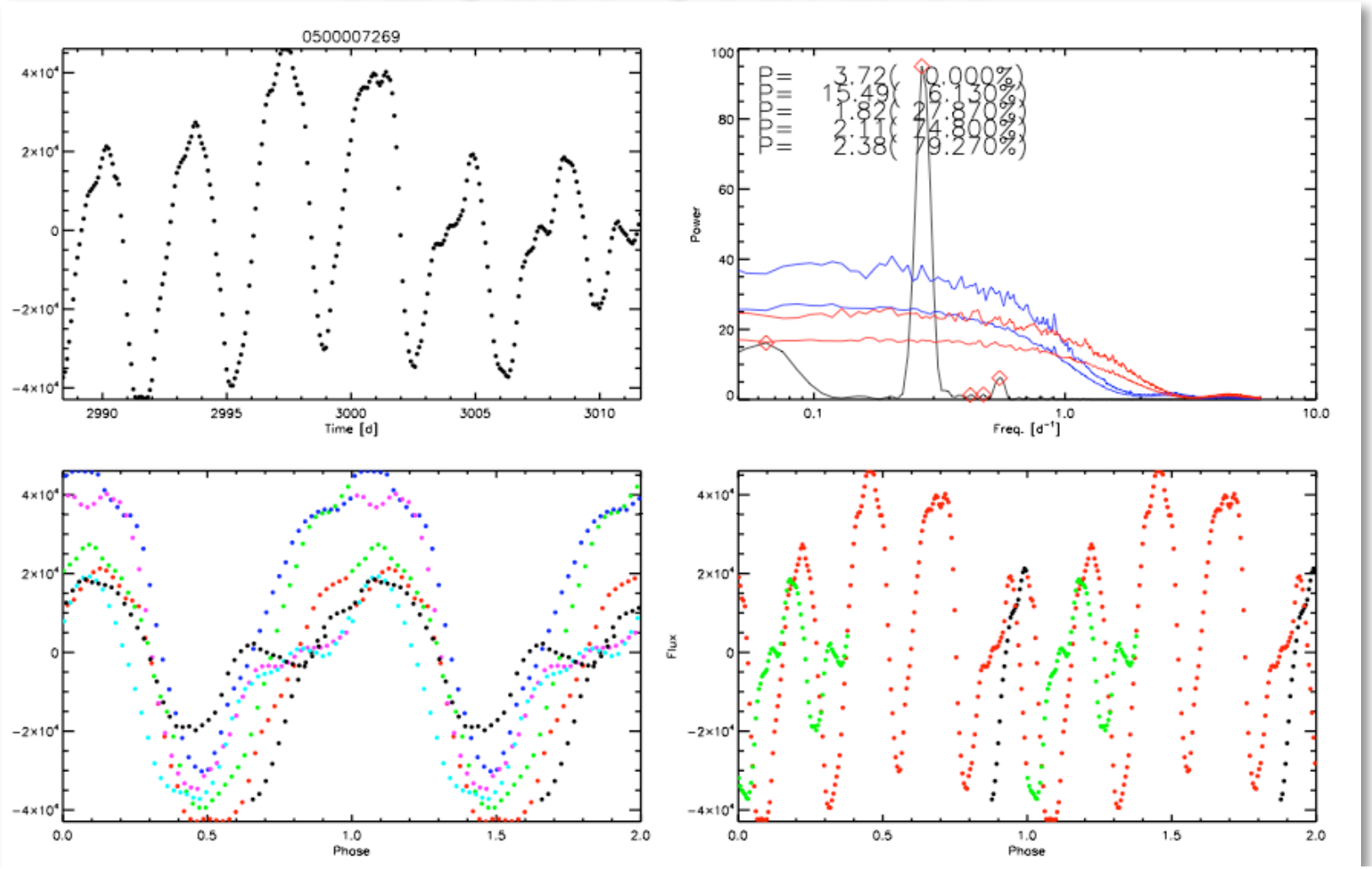
Rotational modulation in NGC 2264 stars from Corot data – fast rotators



Rotational modulation in NGC 2264 stars from Corot data – faster rotators

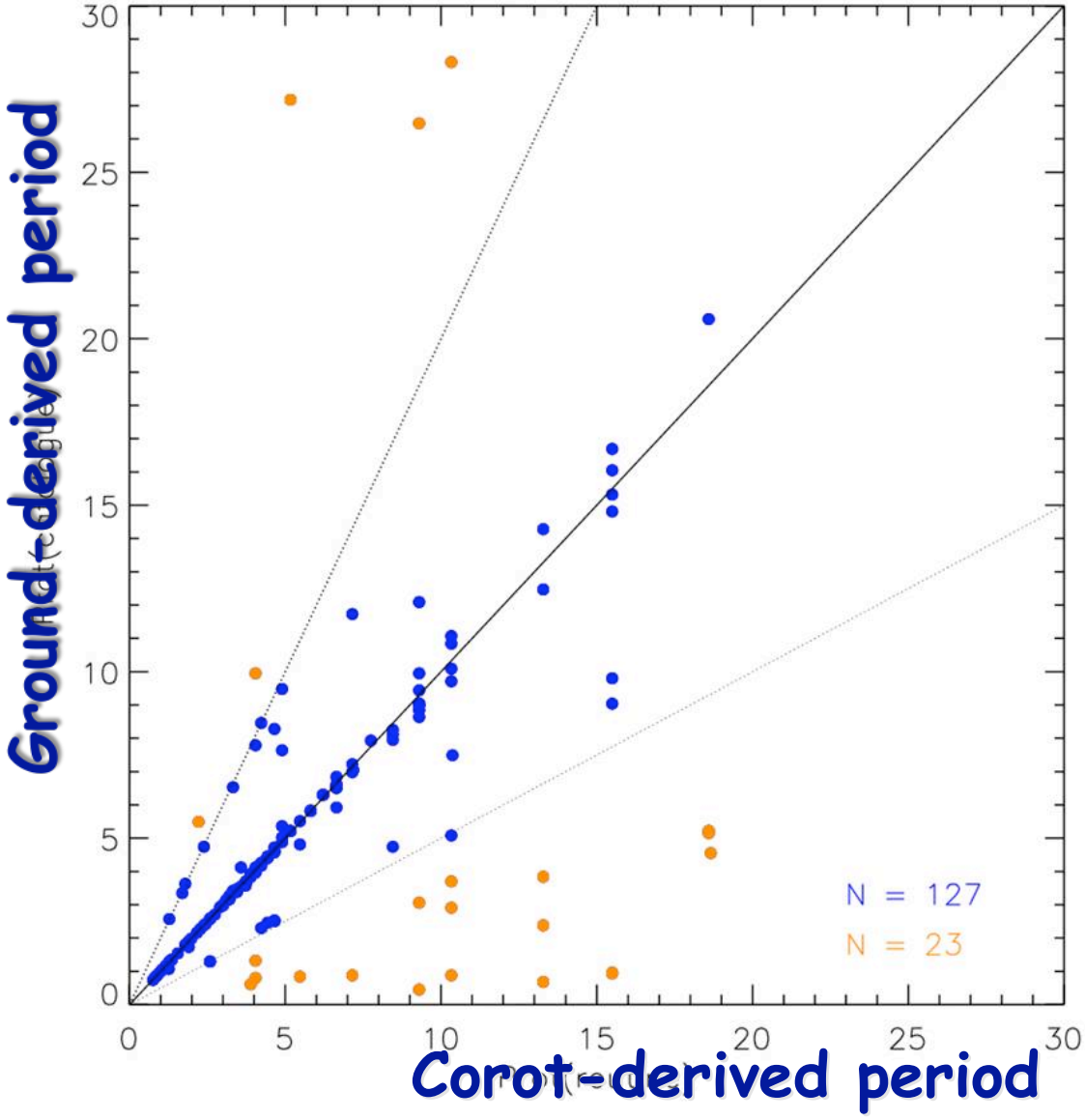


Rotational modulation in NGC 2264 stars from Corot data – evolving surface features

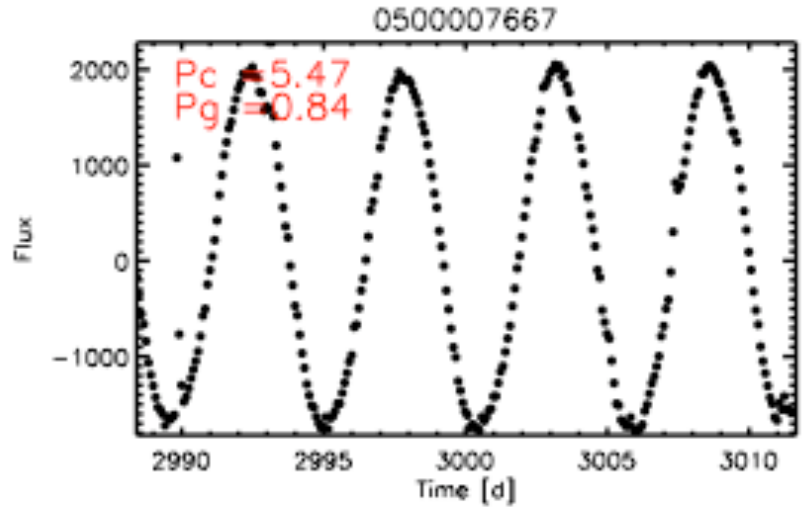


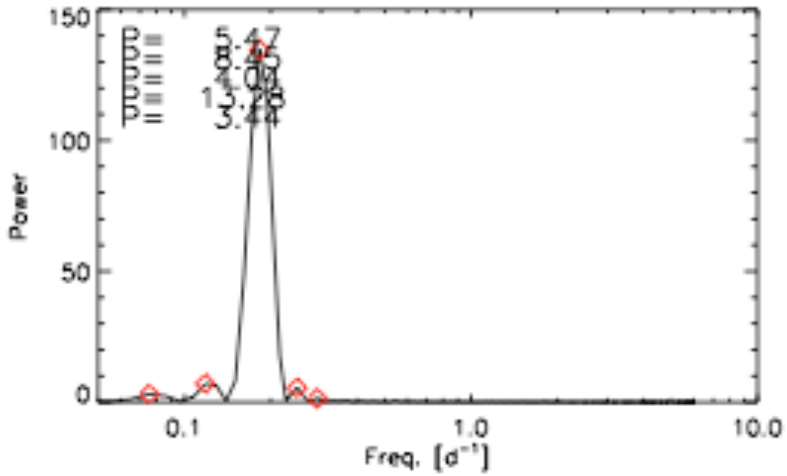
Corot's vs. ground-based periods

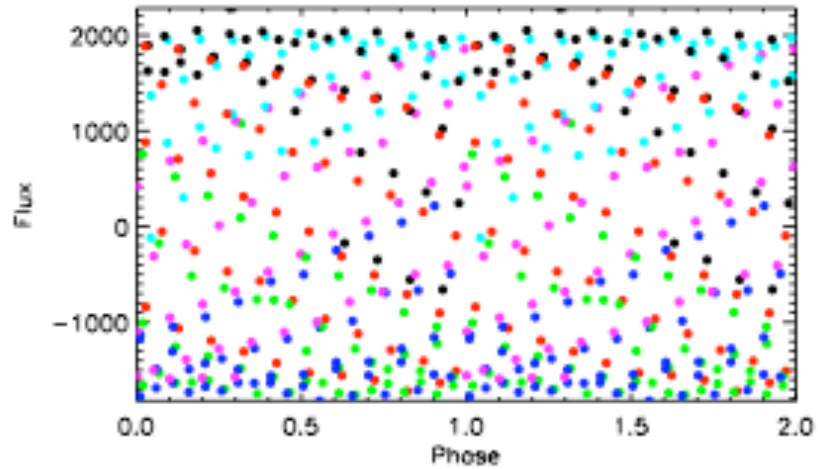
- Mostly within a few %
- Some obvious aliases (0.5 or 2 ×)
- Few oddballs (orange)

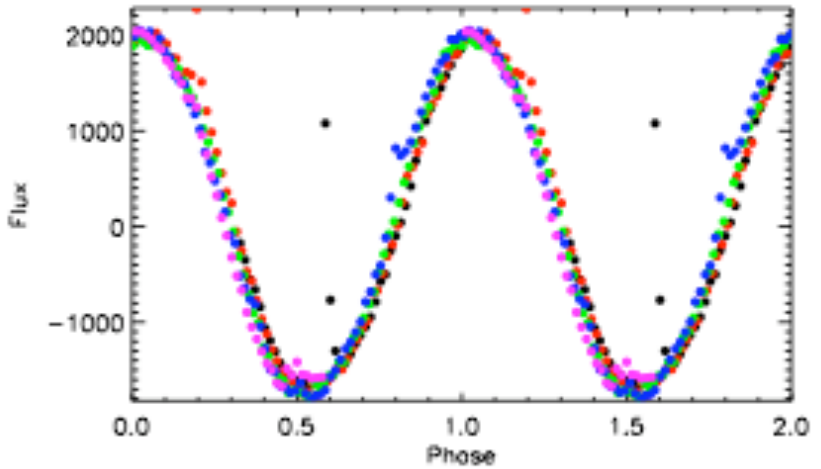


Ground vs. Corot derived folding





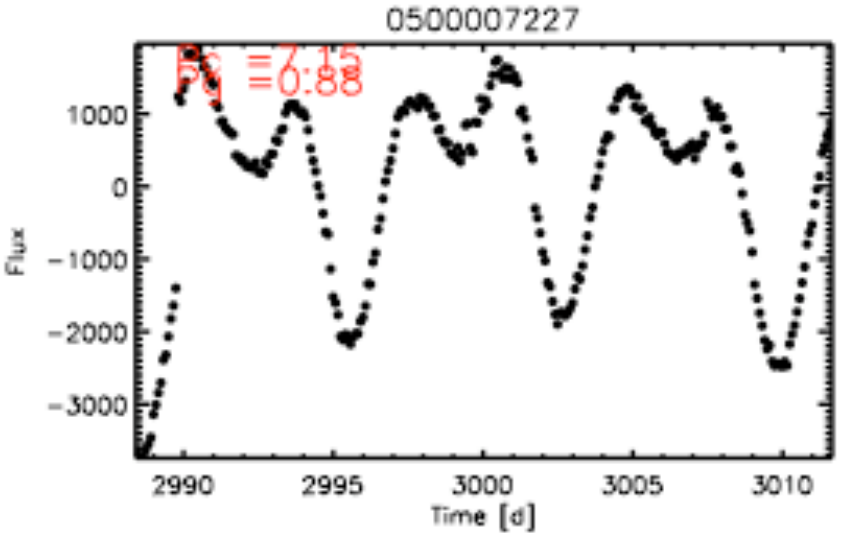


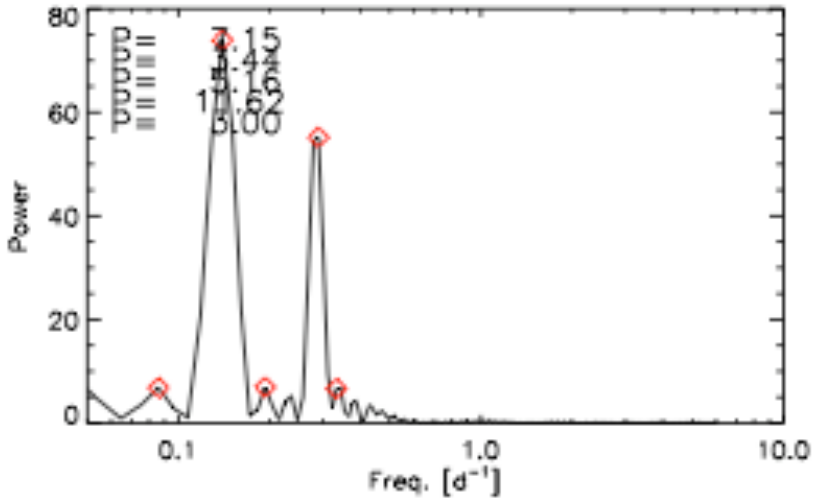


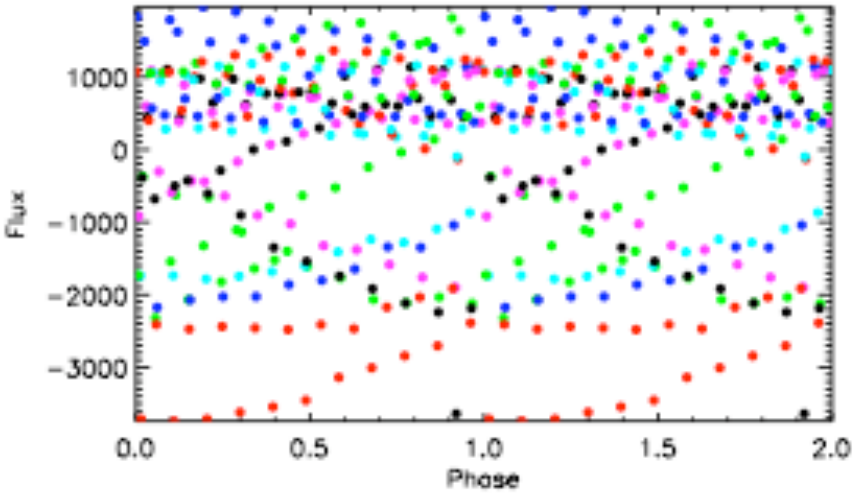
Ground period folding (0.84 d)

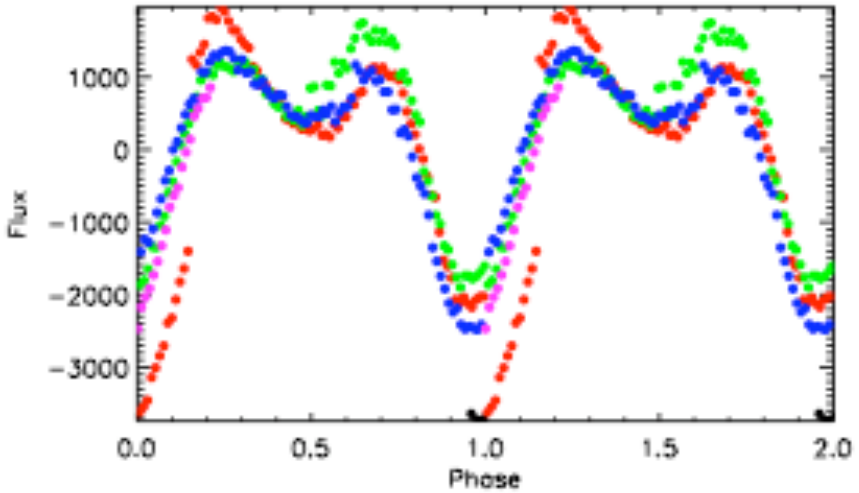
Corot period folding (5.47 d)

Ground vs. Corot derived folding





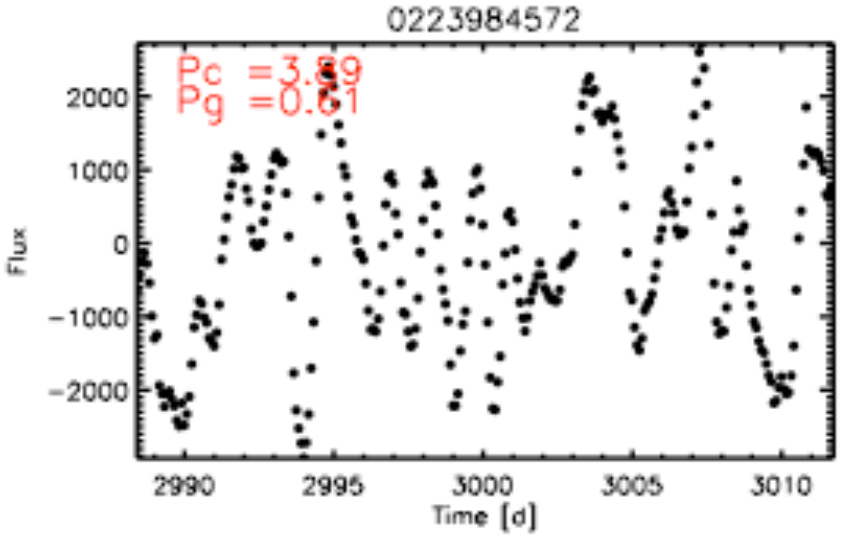


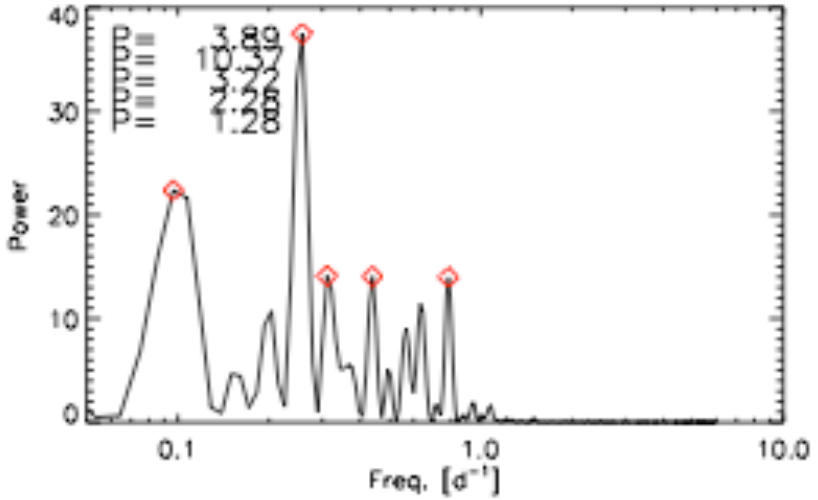


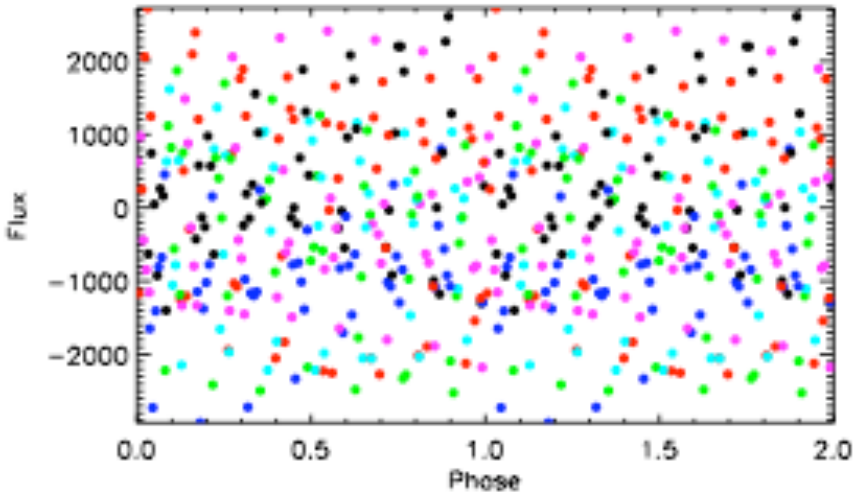
Ground period folding (0.88 d)

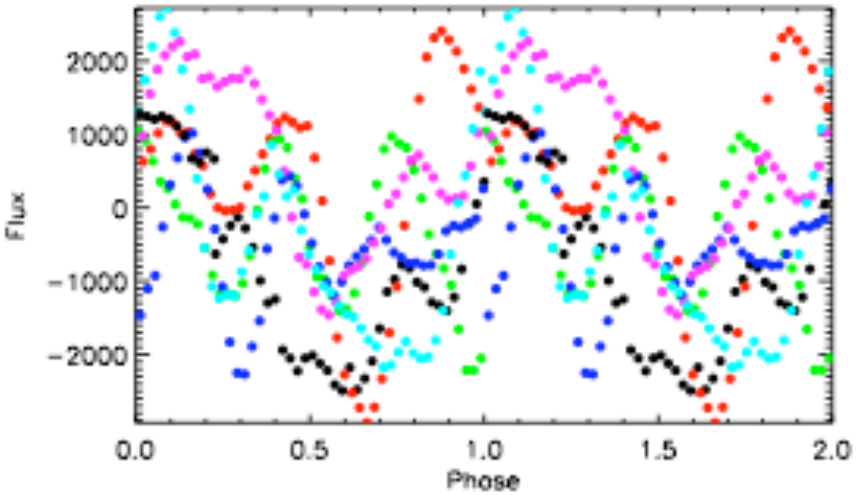
Corot period folding (7.15 d)

Ground vs. Corot derived folding





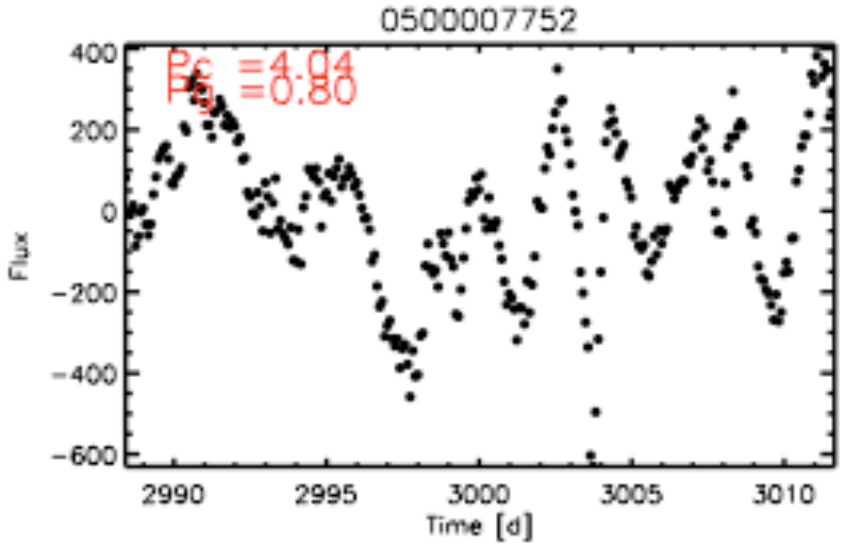


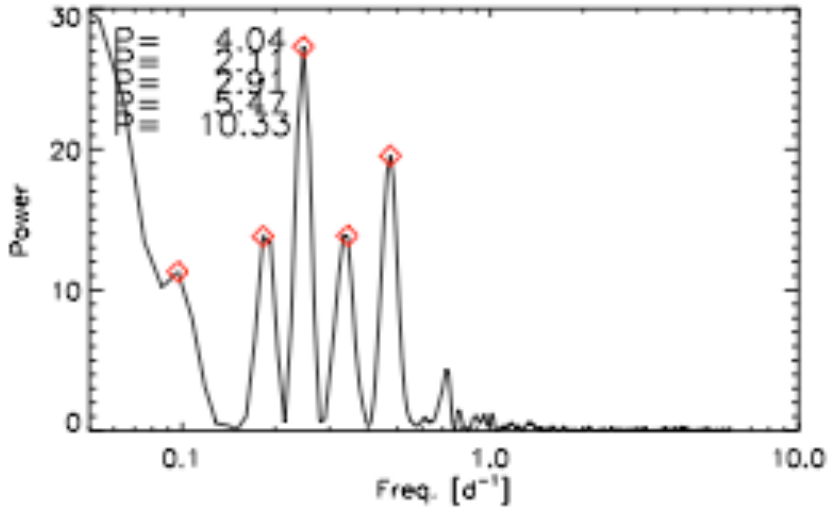


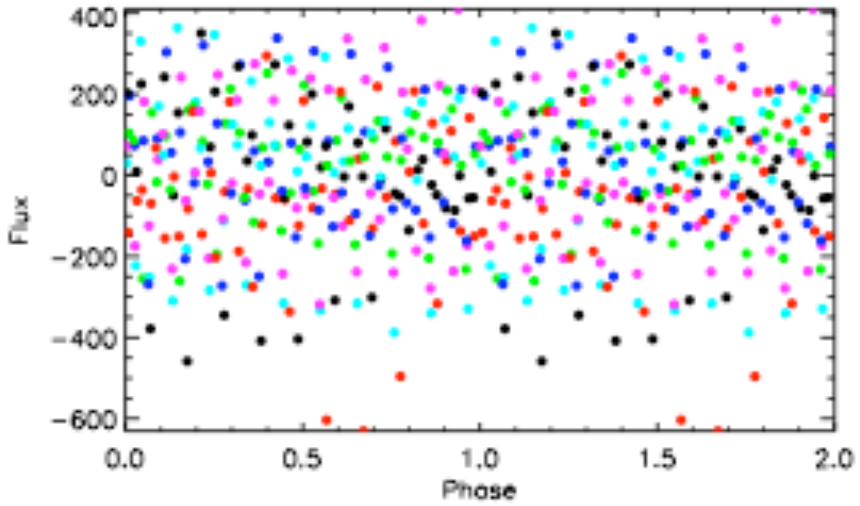
Ground period folding (0.61 d)

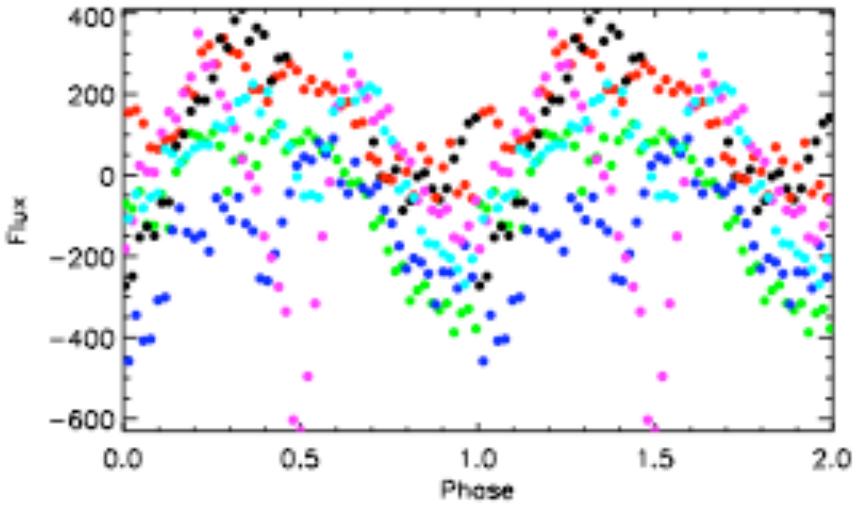
Corot period folding (3.89 d)

Ground vs. Corot derived folding





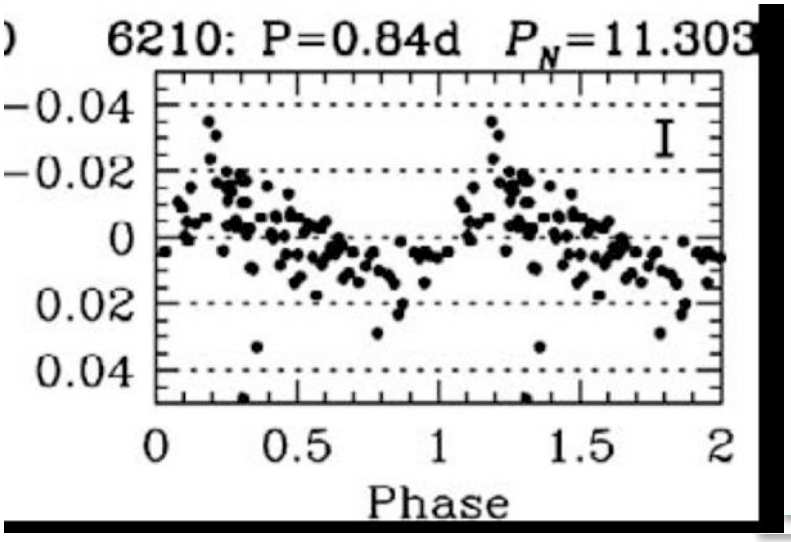


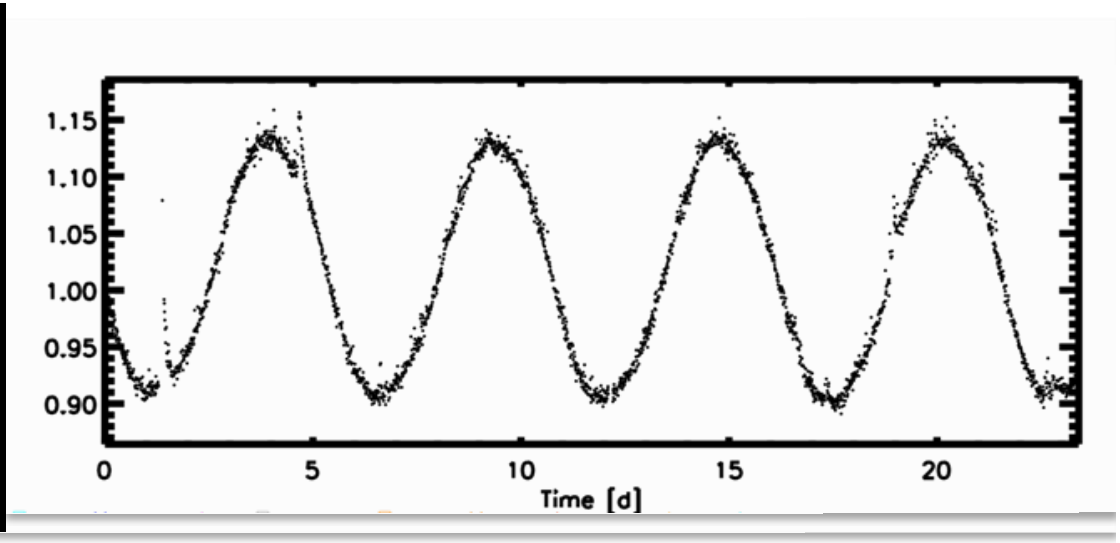


Ground period folding (0.80 d)

Corot period folding (4.04 d)

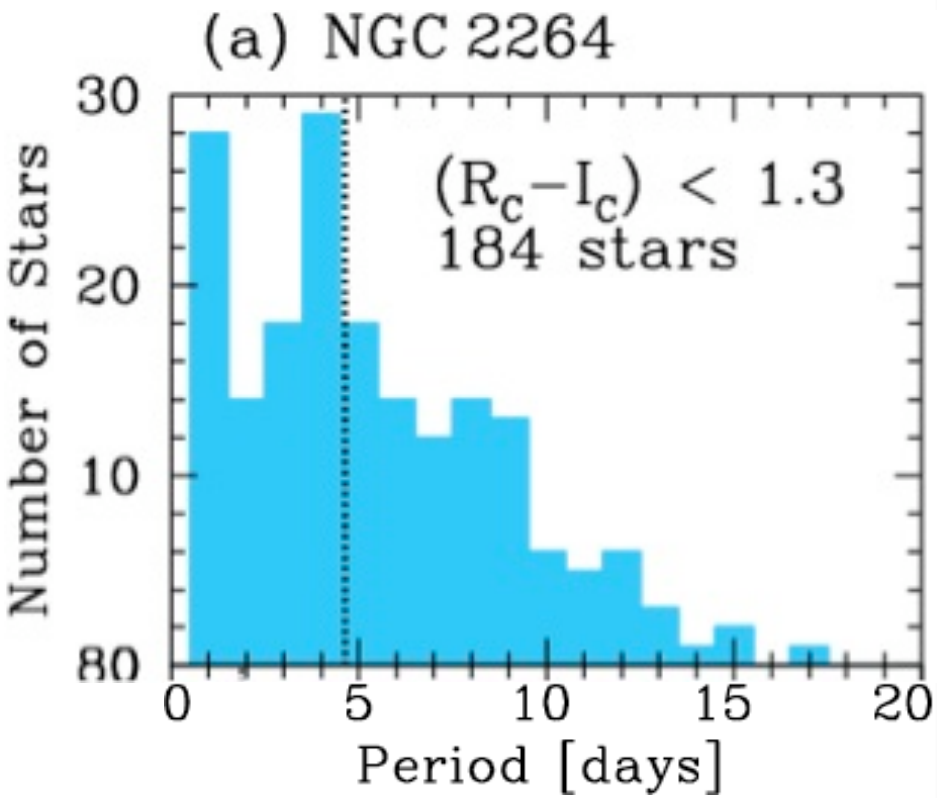
Ground-based observations of short periods

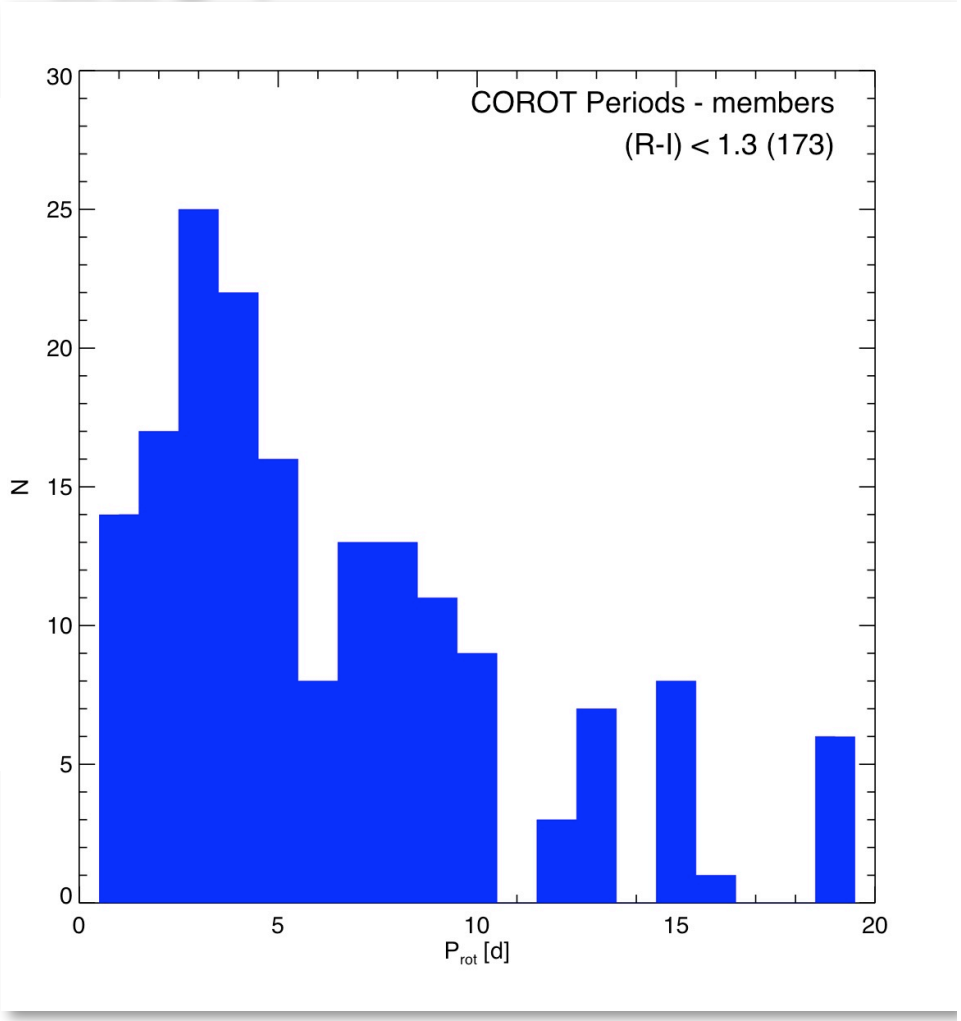




- Ground-based P ≈ 1 d very difficult to do
- Periods likely spurious
- No ambiguity in COROT's data

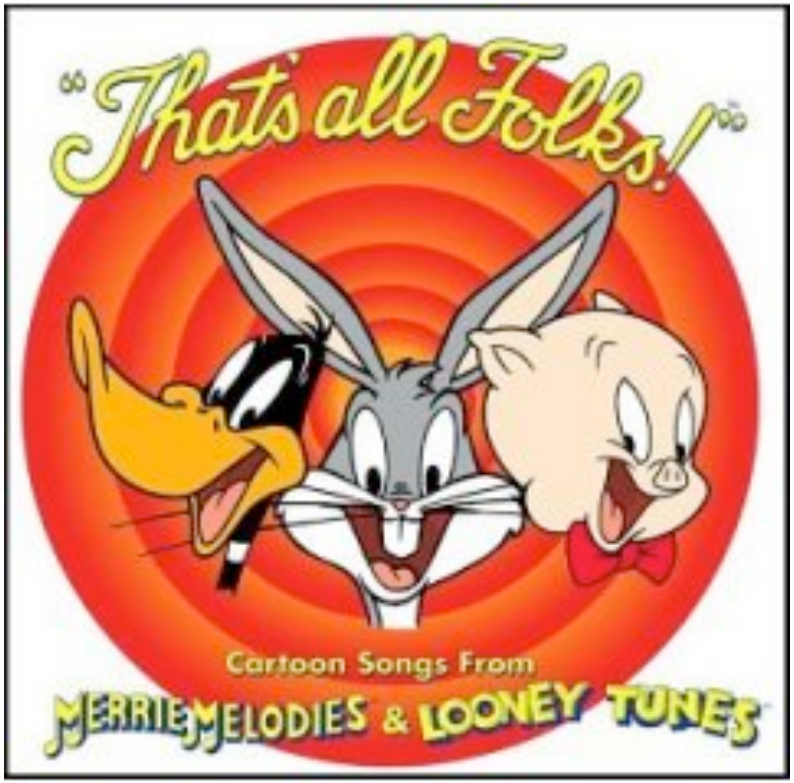
COROT's period distribution for NGC 2264





Conclusions

- Corot's time coverage and photometric quality allow to remove all ambiguities from *P* determinations
- Short periods (≅1 d) much rarer than determined from ground
- No bimodality in the distribution
  - Nature may be simpler than we thought?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