Activity cycles of the red giant star OP And

Differential Rotation
and Magnetism
across the HR Diagram

ESF
Bulgaria
European Social Fund

European Union

Ana Borisova, R. Konstantinova-Antova, A. Antov, R. Bogdanovski
Institute of Astronomy, Bulgarian Academy of Sciences
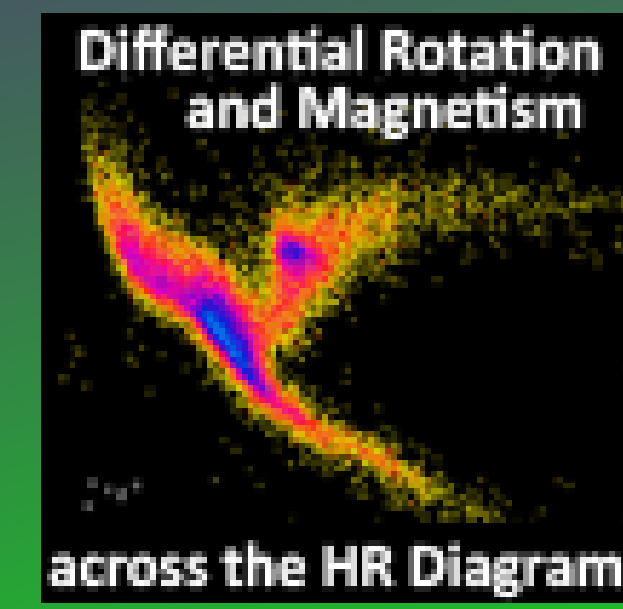
ABSTRACT

We present analysis of the long-term photometric data of the active giant OP And. Our research is based on previously published photometric data, Hyparcos photometric series and observations obtained at Belogradchik observatory, Bulgaria. We provide Bayesian estimate photometric period of the star in the time interval 1983-1999 and compare it with the previous published ones. We have looked for rotational period changes and we are going to search for a possible long-term cycle.

Questions:

Is the period change indication for differential rotation of OP And?

Statistics: Is there robust statistical tool for complex light curves analysis?

Archival data: Is it useful to collect and analyse all of them?

INTRODUCTION

OP And: a single, K1 III, giant star with active chromosphere.

very active: variable and complex brightness modulation due to photospheric cool spots

H&K emissions

partially emission filled Hα line

Periodic modulations of its light curve

Several periods are reported. Larger periods near 60 to 70 days are supposed to be caused by one large spot, rotating with the stellar photosphere, while the shorter period found about 38 days are due to two or more groups of smaller spots. Spot configuration changes?

METHODS

Bayesian statistical methods

Gregory – Loredo (for simple periodical modulation) Bayesian statistical method for study of the stellar variability.

Uses Gaussian error distribution and Jeffrey's priors for estimating the probability for constant, periodic and variable brightness variation. Problem – light curve appears complex, need to get

Used in our previous study of the active giant star CF Oct. Need for a tool of complex light curves analysis.

Why Bayes? Hypothesis testing, error analysis, sparce data set, relatively fast, priors and prior information

REFERENCES

ESA, 1997, The Hipparcos and Tycho catalogues, ESA SP-1200

Borisova, A. P., Hambaryan, V., V., Innis, J.,L., 2012, MNRAS, 420, 2539B

Barksdale, W. S., at al. 1984, IBVS2632

ESA, 1997, The Hipparcos and Tycho catalogues, ESA SP-1200

Fekel, F. C. , Moffett, T. J., Henry, G. W., 1986, ApJS, 60, 551

Gregory, P. C., 1999, ApJ, 520, 361

Gregory, P. C., Loredo, T. J., 1992, ApJ, 398, 146

Konstantinova-Antova, R. at al., 1995, Proc. Of IAU Symp. 176

Konstantinova-Antova, R., Antov, A., 2000,Kinematika i Fizika Nebesnykh Tel, Spl,3,342

Konstantinova-Antova, R. at al., 2005, Proc. 13 Cool Stars Workshop, ESA SP, 560, 715

Konstantinova-Antova, R. at al., 2009, IAUS, 259, 433K

Strassmeier, K. G and Hall, D., 1988, ApJS, 67

Strassmeier, K. G. at al. , 1990, ApJS, 72, 191

Smith, G. H., Shetrone, M. D., 2000, PASP, 112, 1320

PHOTOMETRIC DATA

1983 – 1986:

Sources:

Barksdale et al. 1984, Strasmeier and Hall, 1988 periodical modulation with period

Published data Gregory-Loredo method gives:

36.8 d in 1983 p=41.8 +/- 1.1 d

66.4 d in 1984 p=63.8 d

76.0 d in 1985 p=63.8?, 69.1?, 77.6? 90.9?

All the data give indication for a very complex model of the light curve

1990 – 1993:

Hipparcos photometry + Gregory-Loredo

P=32.26d and P=64.94d +/-0.7

Belogradchik Observatory data

Konstantinova-Antova and Antov, 2000

1995 – 1996 p= 76 d

Gregory-Loredo method

1994 p=40.65 +/-1.2d

1995 p=57.5 +/- 1d , 76.0 +/-2.0d

1996 p=86.2 +/-1.1d

1997-1999 p=73.2 d +/-1.0d

SPECTRAL DATA

1979 – 1996:

star is extremely active at 90'ties with strong asymmetric single peak CaII H&K emission, filed-in H alpha core and blue-shifted emission
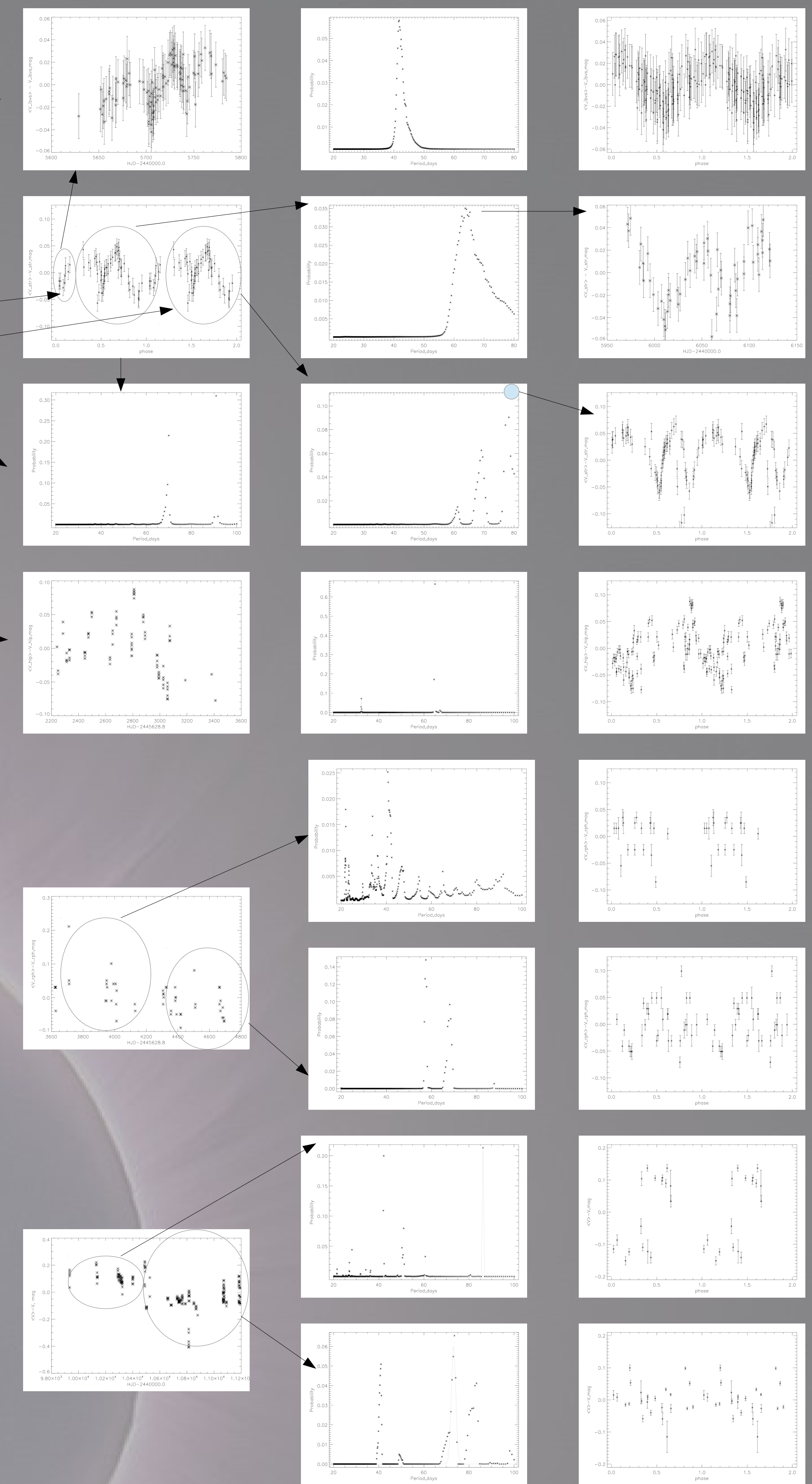
2008 and 2010:

the star is in a low activity stage, clearly distinguished double peaked CaII H&K emission

Long-term behaviour of the spectral activity indicators: Ca II H line emission (left) and Hα absorption core intensity

ACKNOWLEDGEMENTS
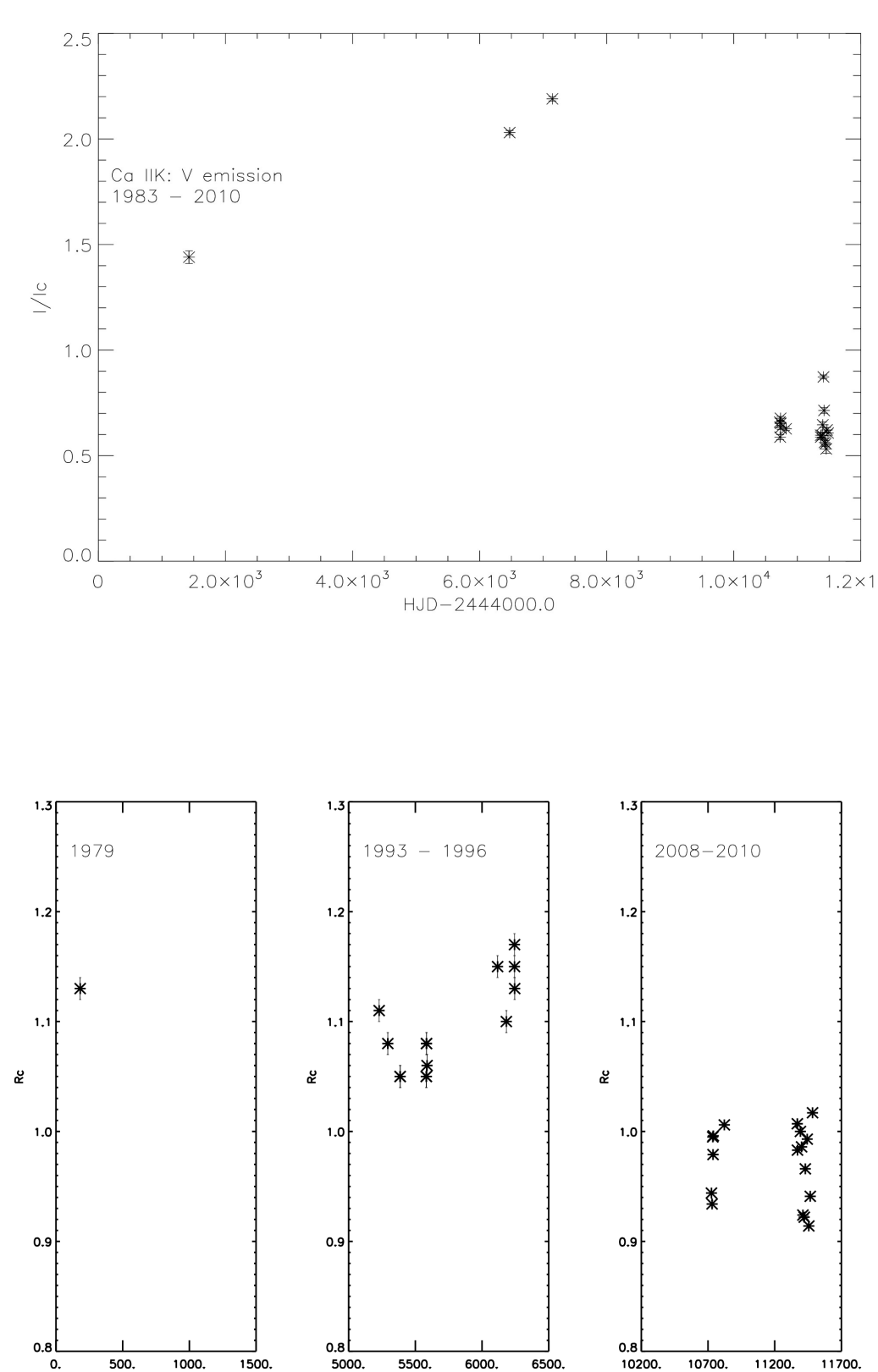
RESULTS

CONCLUSIONS

Photometric variability of OP And is very complex and we need to develop and apply advanced statistic.

Photometric periods between 60 and 80 days clearly correspond to rotational period of the star and are due to the rotation of one large polar spot.

Short periods, near 30 – 40 day corresponds to configuration of two spot groups, distributed symmetrically on the star surface.

Longer periods are probably harmonics of the shortest period.

Photometric data we have are in the period of a hight activity state (according to the spectral observations) of the star. Is there relation between activity level and complexity of the light curve?

For questions, discussions and collaborations, please mail me: aborisova@astro.bas.bg

NORDITA conference: Differential rotation and Magnetism across the HR diagram, 2013 April, Stockholm

Investing in your future!