Photometric activity cycles and activity indicators of the red giant star OP And

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Introduction

OP And is a single, K1 III, giant star with active chromosphere. Its activity is evident with variable and complex brightness modulation as a result of photospheric cool spots as well as with strong Ca II H&K emissions and partially filled in by emission Hα core. Magnetic field was also detected, Konstantinova-Antova et al. (2009)

Periodic modulations of its light curve are known from previous studies in different epochs of observations. 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.

Purpose

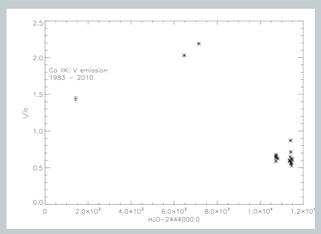
Our work aims to perform a detailed study of the photometric behaviour and spectral activity indicators of the star, using all the available archival data and reasonable statistical methods. Thus we will obtain additional information for stellar rotation and activity cycles of this star to be in use in the future studies of its magnetic field, activity and evolution.

Future

Next step of our work is the analysis of the long-term photometric variability of OP And and search for activity cycles.

Results:

Spectral observations 1979 – 2010: 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.



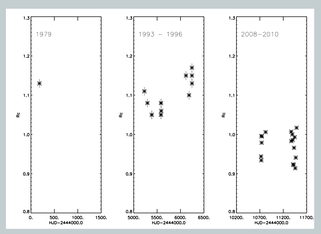


Fig. 6 Long-term behaviour of the spectral activity indicators: Ca II H line emission (left) and Hα absorption core intensity

Aknowledgements

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2008 NARVAL observations are supported by the OPTICON program

TBL team supported the obsevrational program

Hipparcos and Tycho photomety data was used

Bayesian statistical methods

- Gregory – Loredo 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
- Used in our previous study of the active giant star CF Oct

Data in Use

In general the data are sparse, randomly distributed in time, with different errors, large intervals with data-gaps. So we need Bayesian.

photometric data sources:

- 1983 – 1986: Strasmeier and Hall (str), 1988 , Reported for periodical modulation with period of 36.8 d in 1983 by the use of data from Barksdale et al. 1984, 66.4 d in 1984, and 76.0 d in 1985
- 1990 – 1993: Hipparcos photometry time series data, to be analyzed in the present study (hyp)

1994 – 1999: Belogradchik Observatory electrophotometry, Konstantinova-Antova and Antov, 2000. Estimated period of 76 d for 1995-1996, and 37 d for 1994-1995

spectral data sources for Hα and Ca II H&K lines:

Fekel, Moffet, & Henry, (1986)
Strassmeier at al. (1990),
Konstantinova-Antova at al. (1995, 2005)
Konstantinova-Antova (2001)
Smith & Shertone (2000)

2008 and 2010 observations with 2m Telescope Bernard Lyot, Pic du Midi Observatory, France

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Results

1983 – 1986: Bayesian period estimation give results close to the published ones, period of 41.8 +/- 1.1 d for 1983, 63.8 d for 1984 and 77.7 +/- 1.2 d for 1985. We have also find a period of 69.9 +/- 2.1 d over all the 1983 to 1986 data.

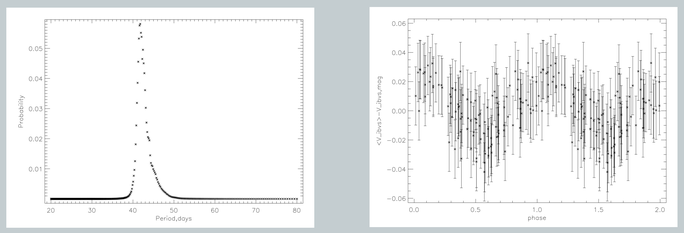

Fig 1. Probability density function (left) and light curve ploted with 41.8 d period for 1983 – 1984 data

1990 – 1993:

Bayesian period estimation over the Hyparcos data reveals period of 64.9 +/- 0.17 d

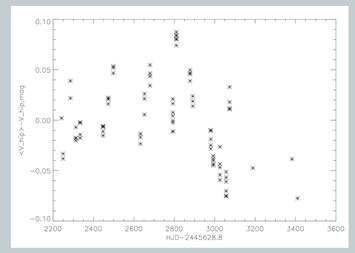

Fig. 2 Mean subtracted Hiparcos V photometry

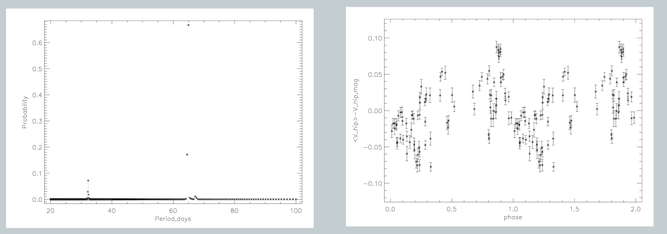

Fig 3. Probability density function (left) and V light curve ploted with 64.9 d period for 1990 – 1983 data

1994 – 1999: We found clear evidence for periodical modulation with period of 73.2 d for 1996.

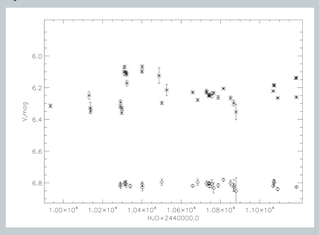

Fig. 2 V photometry for the interval Oct 1996 – Dec 1999 for OP And (asterics) and the chek star HD 9901 (diamonds)

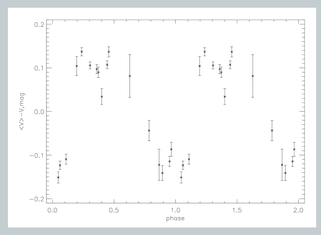

Fig. 5 Light curve in V band ploted with 73.2 d period for 1996

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