



Variability of Massive Stars with Known Spectral Types in the Small Magellanic Cloud Using 8 Years of OGLE-III Data



Michalis Kouriotis

*National Observatory of Athens
& University of Athens, Greece*

M.Sc. Thesis Supervisor

Dr. Alceste Bonanos

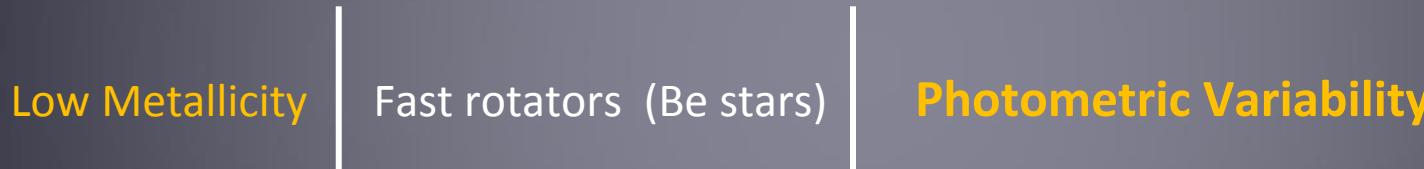


Introduction : Massive Stars & Variability

- Stars of mass $\geq 8M_{\odot}$
- Short lifetime
- Mass depends on metallicity

$$\dot{M} \propto Z^{0.69 \pm 0.10}$$

(Vink et al. 2001)

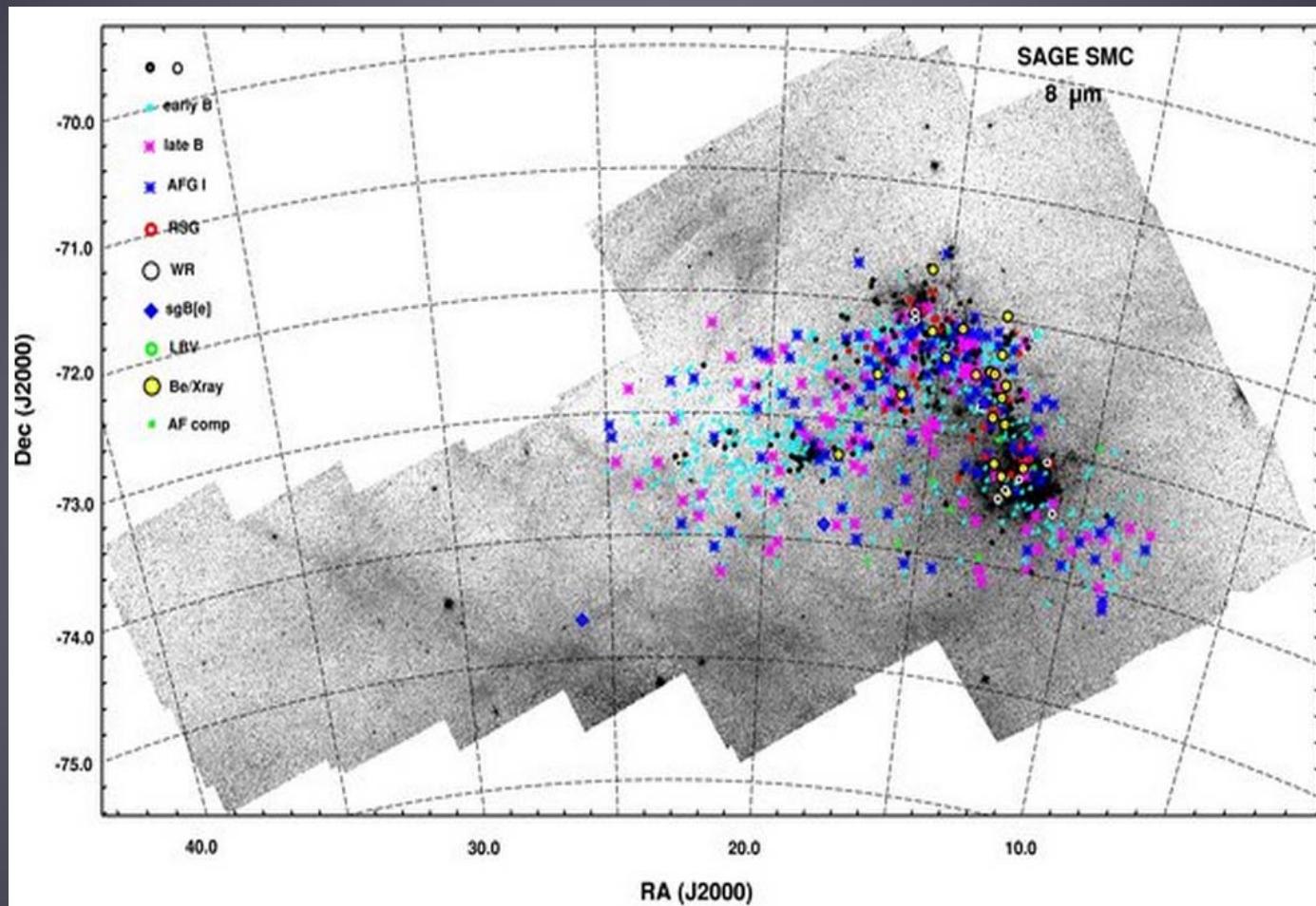


The Goals:

Study long-term light curves of hot massive stars of the SMC to

- identify photometric Be stars
- discover eclipsing binaries
- derive statistics for variability

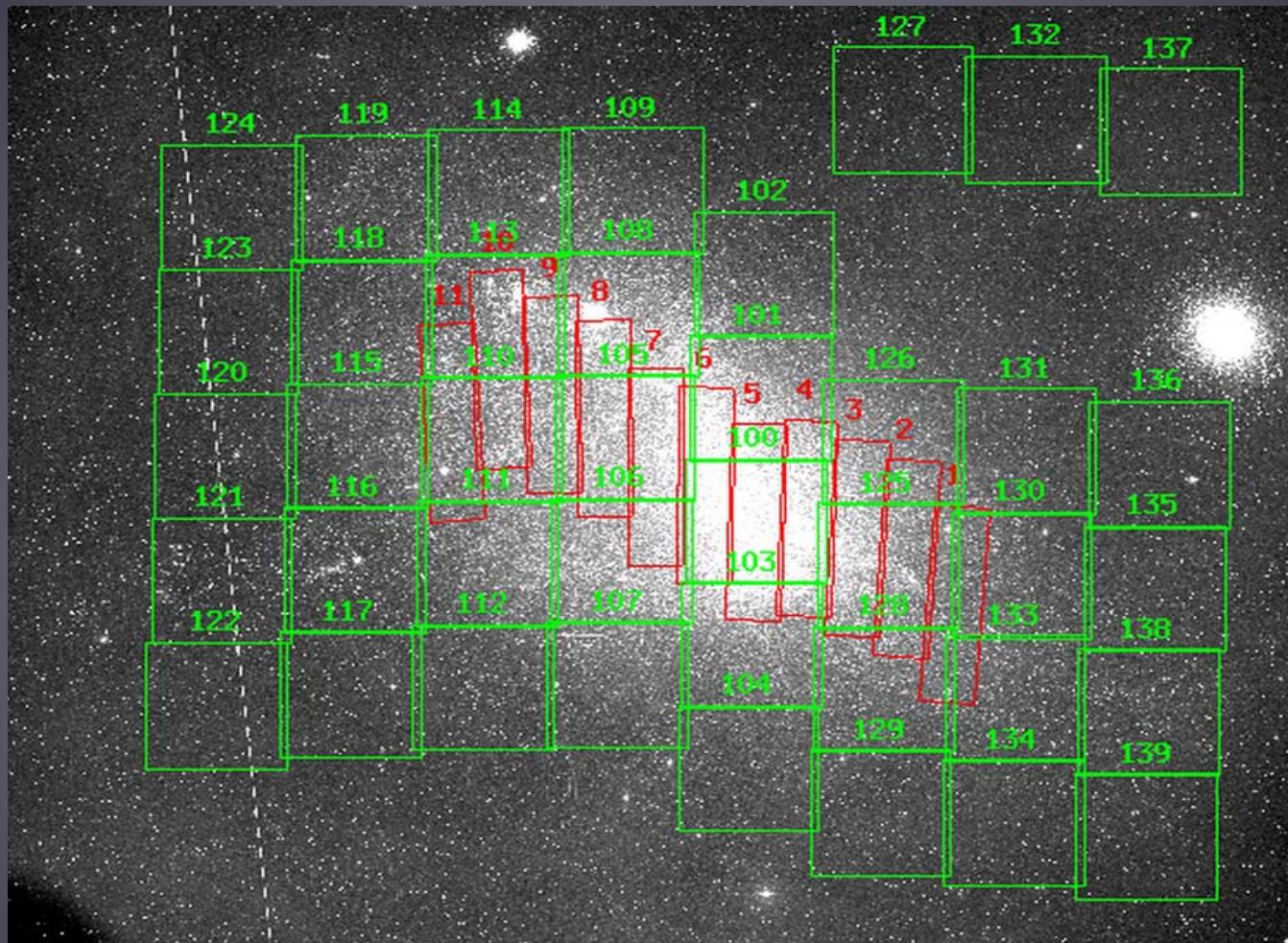
Input Catalog



5324 massive stars in the SMC

Bonanos et al. (2010)

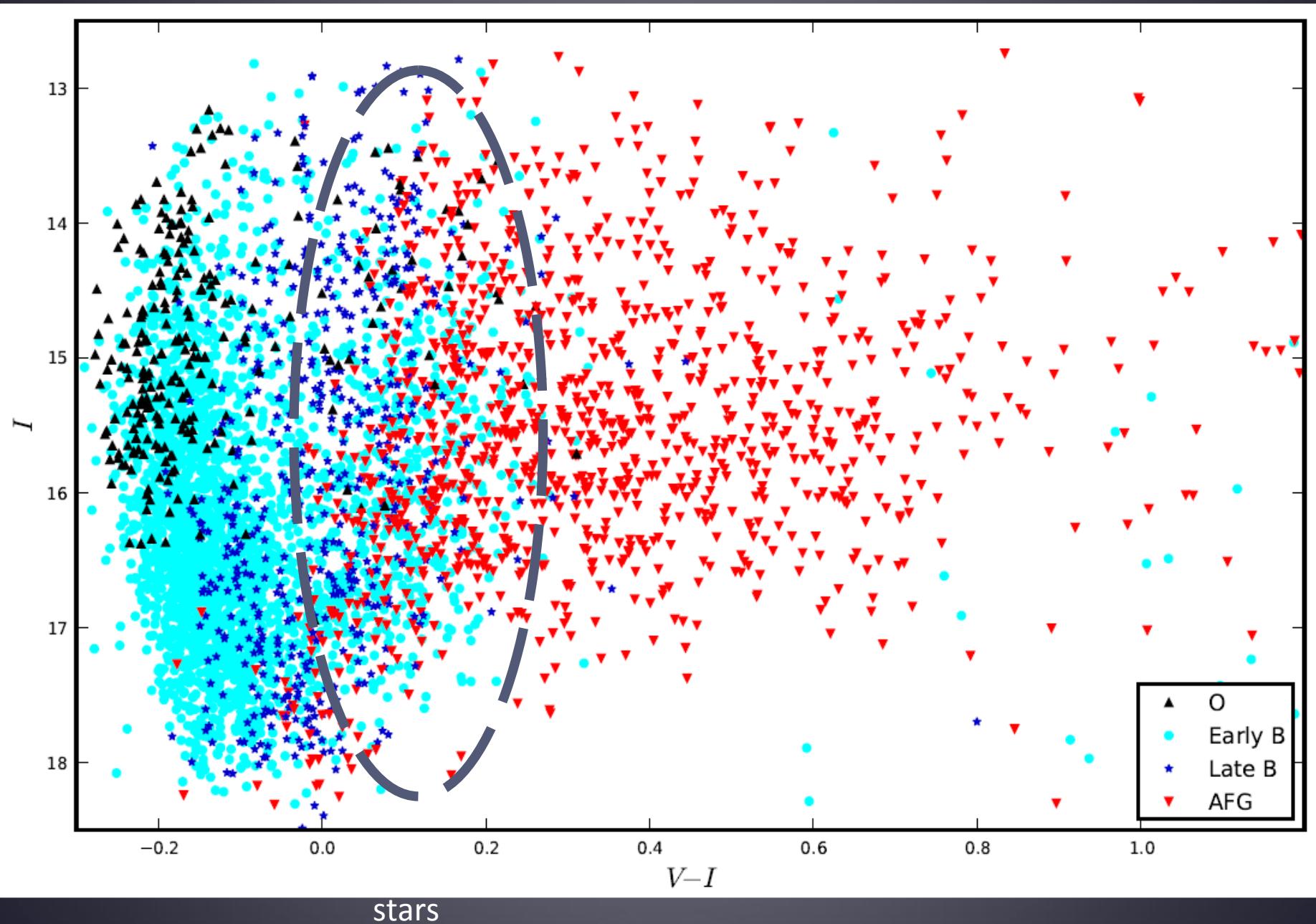
OGLE-III survey & matching



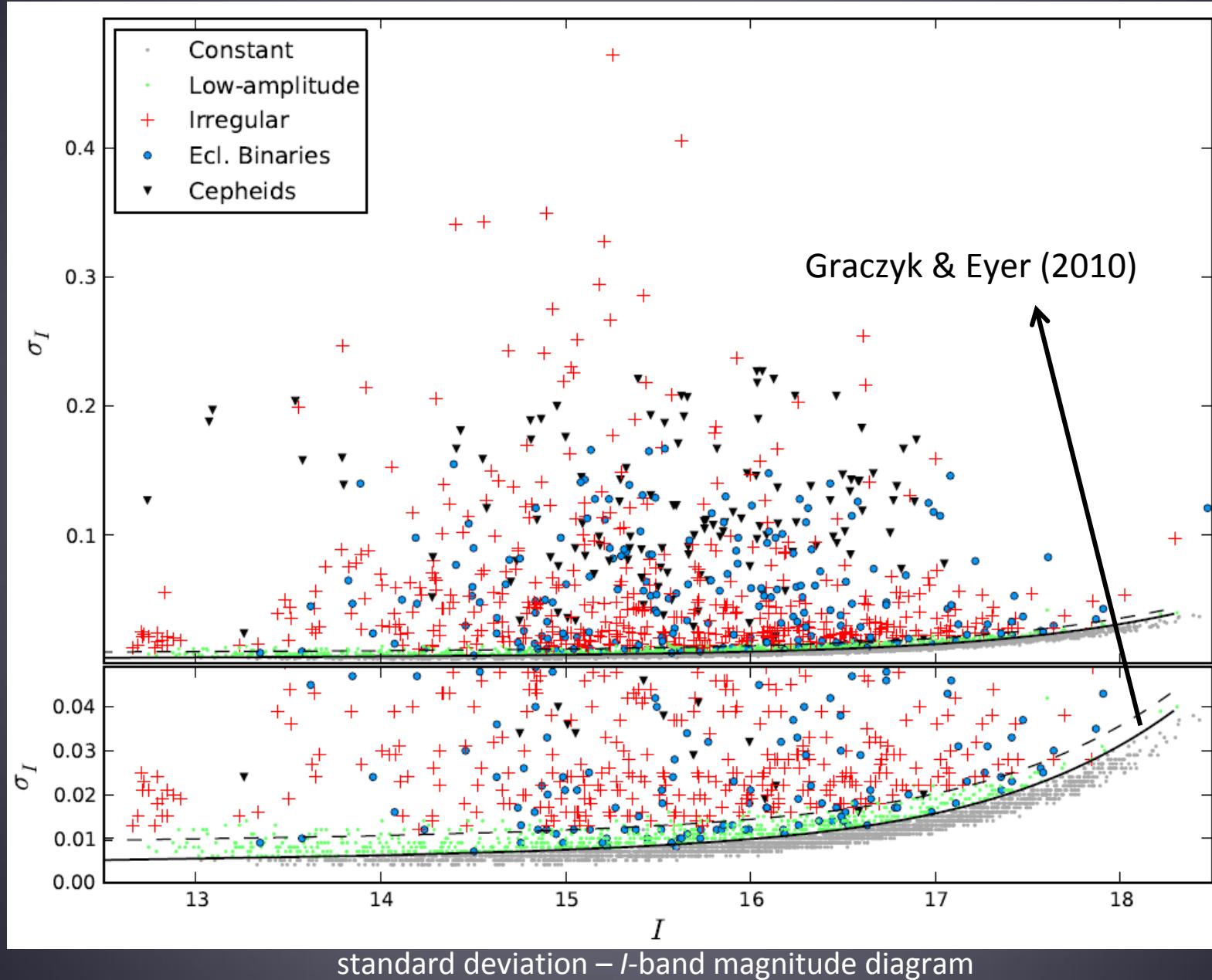
- 2001 – 2009
- 5.5 million sources in the SMC
- 600 measurements in the I-band

4650 matched stars

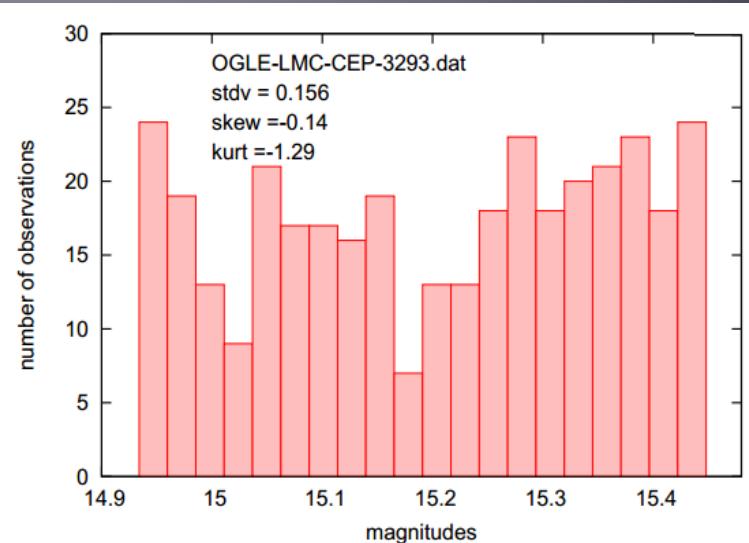
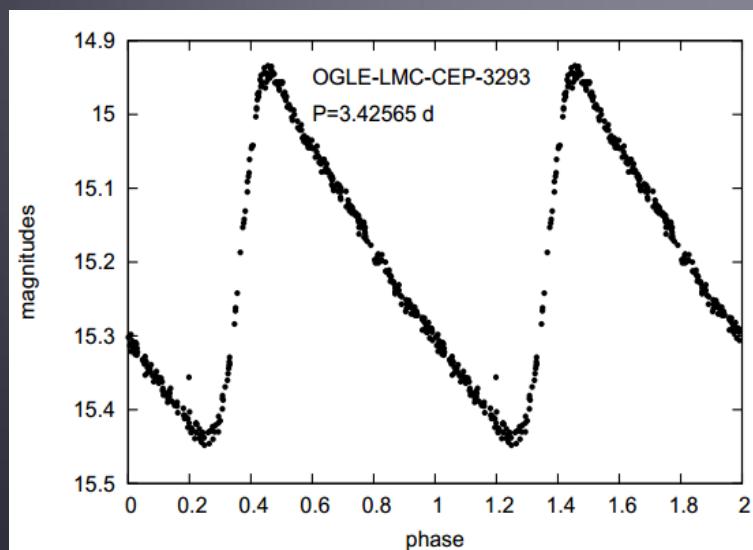
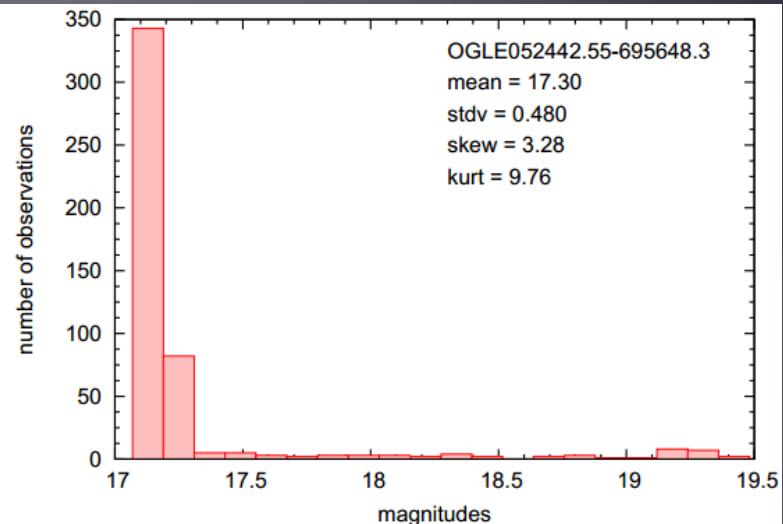
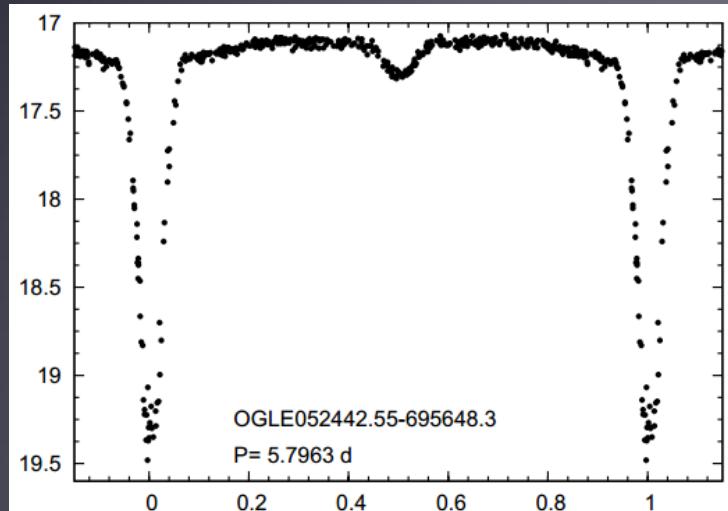
Color-magnitude diagram



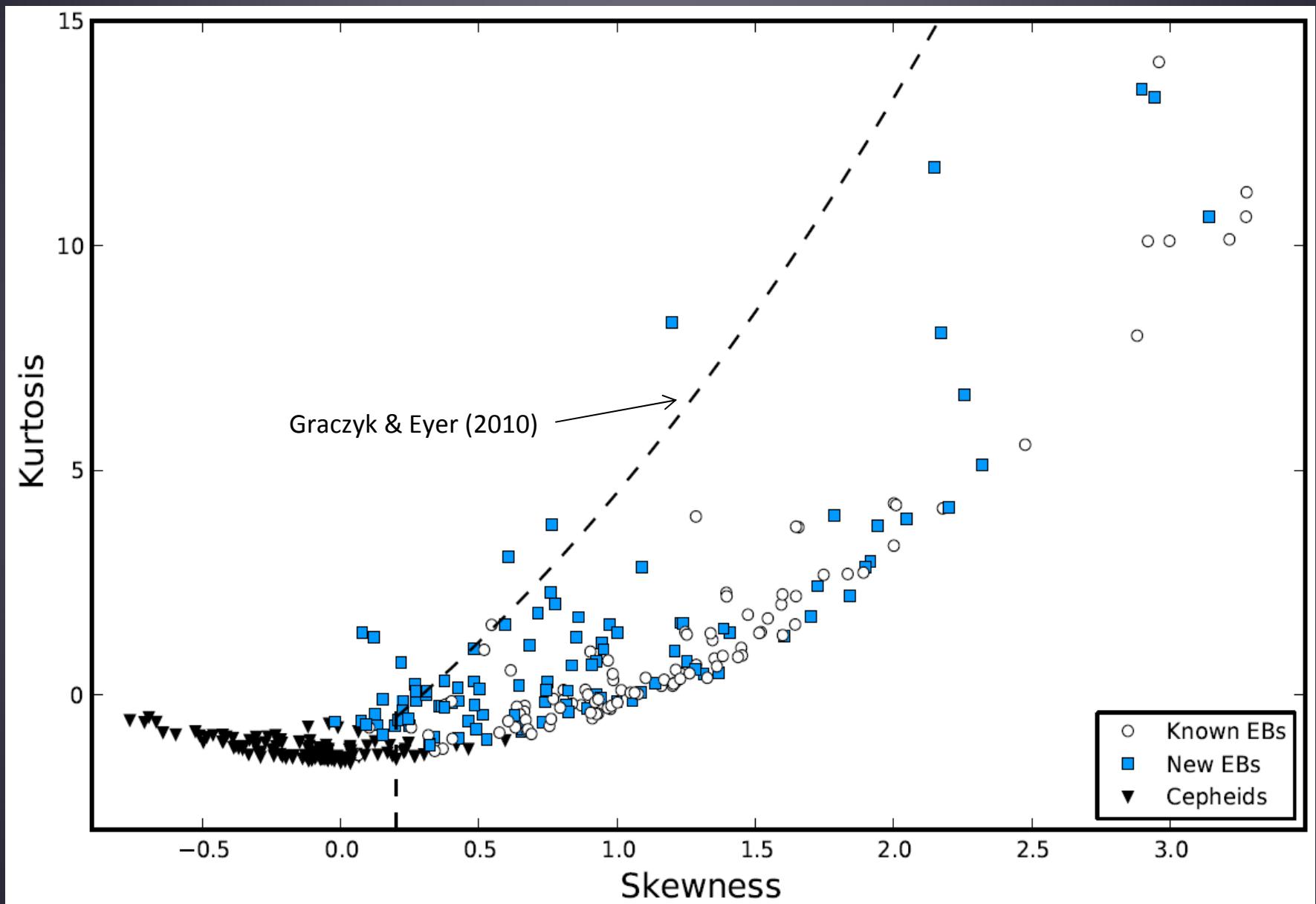
Method for Defining Variables



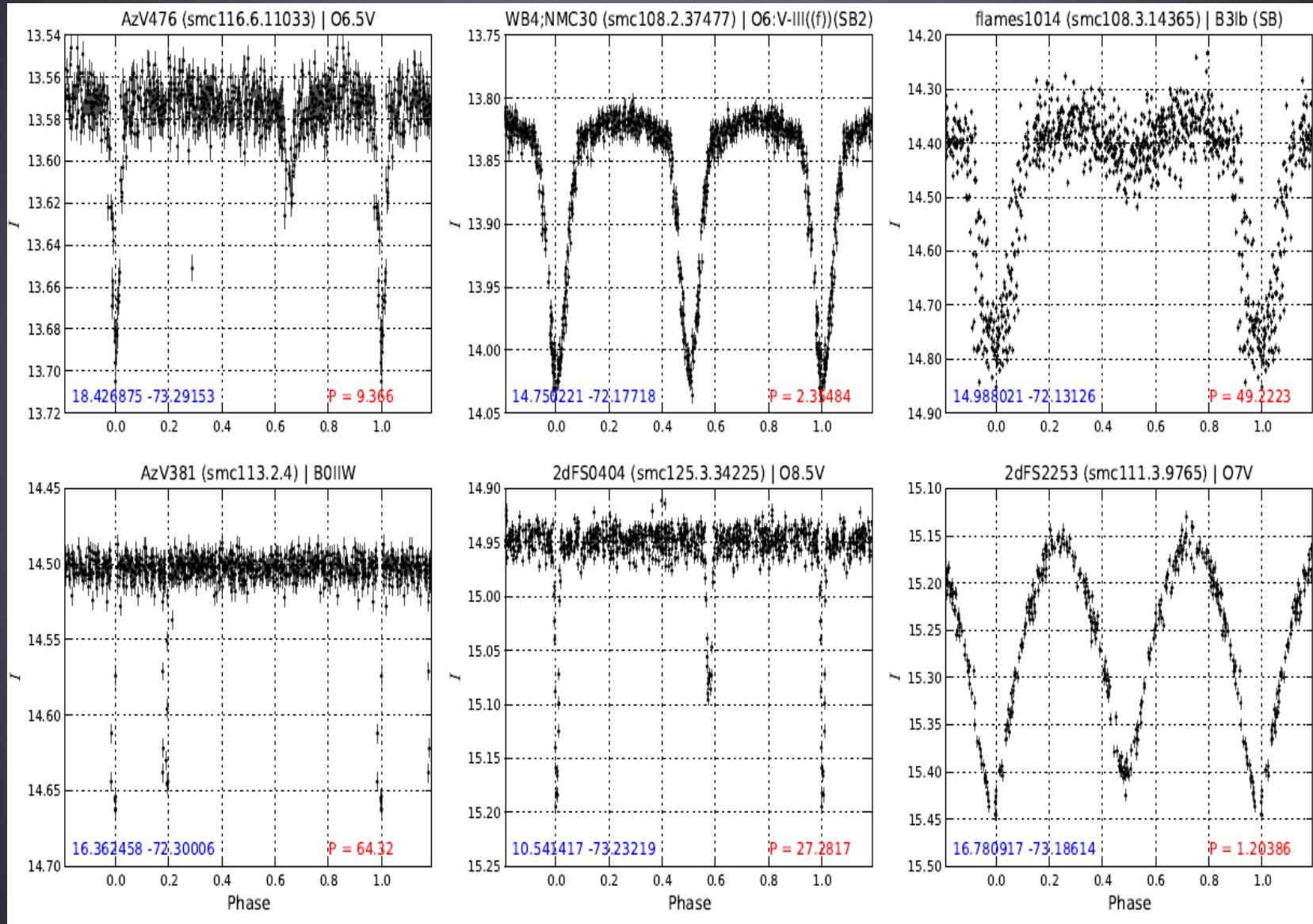
Identifying Eclipsing Binaries : Skewness & Kurtosis



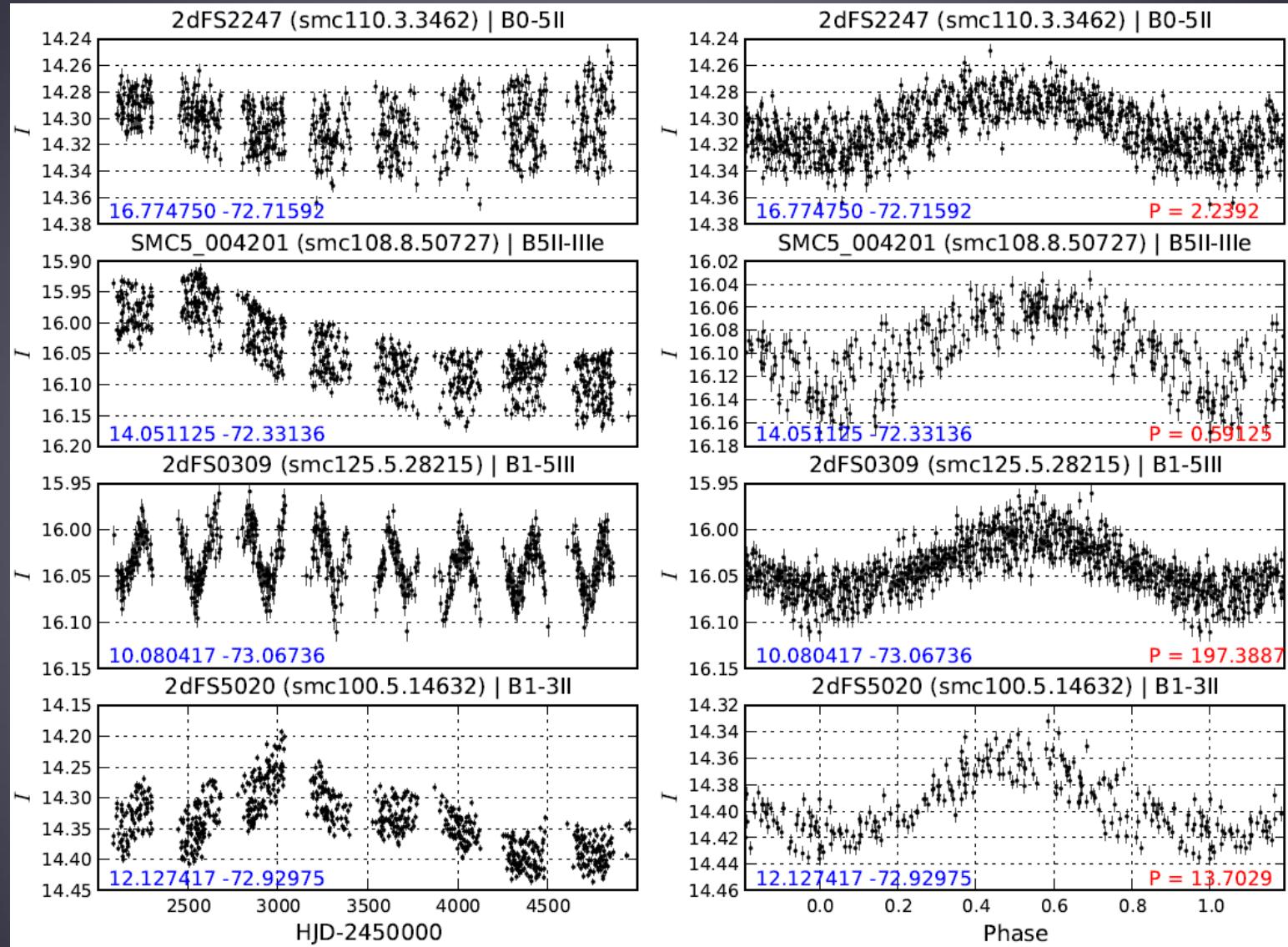
Identifying Eclipsing Binaries : The Diagram



Results : 108 Newly Discovered Eclipsing Binaries



Results : Other Periodic Variables

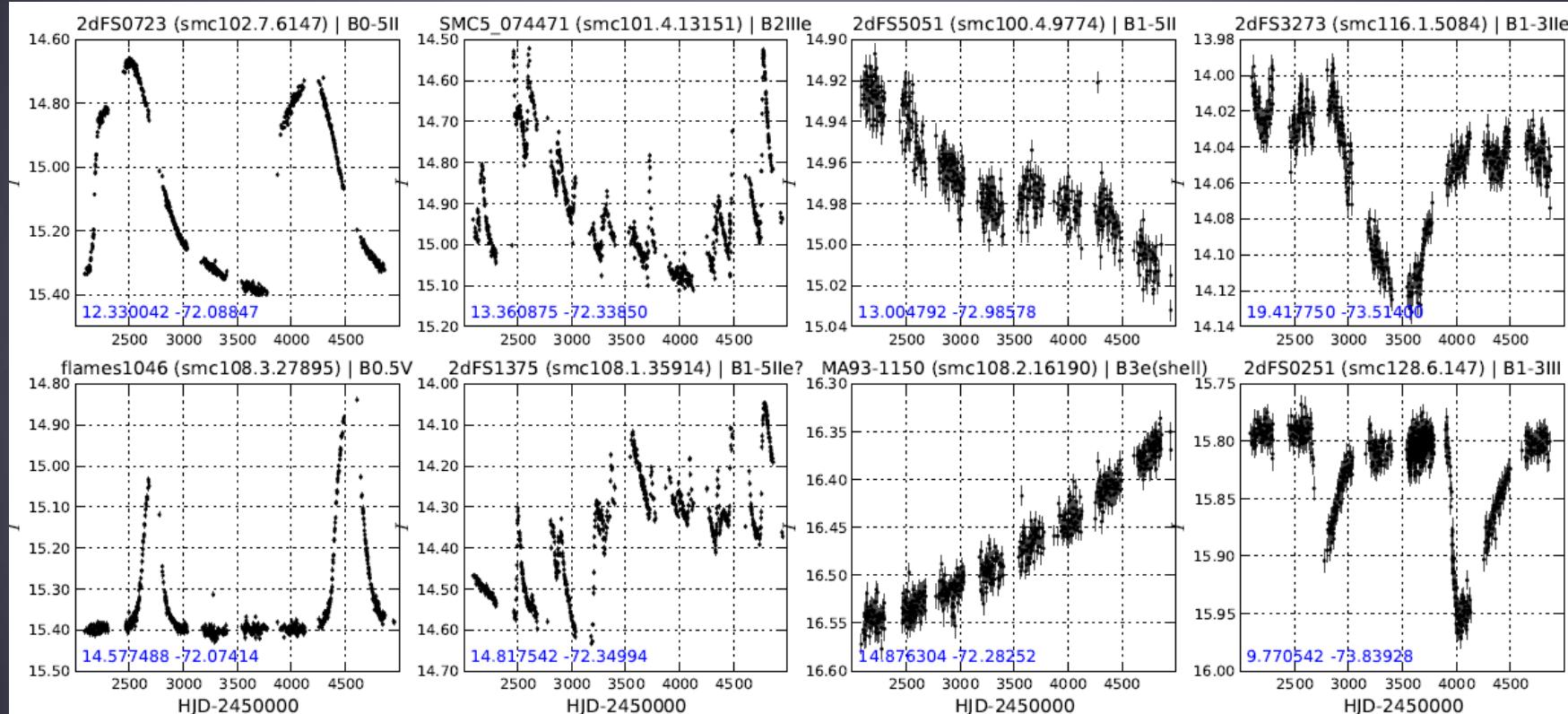


- 139 short-period variables & 51 short-period (+ extra var.)
- 42 long-period variables & 14 long-period (+ extra var.)

Results : Irregular Variables

444 irregular variables

~ 80% are new discoveries



Bumper

High amplitude

Flicker

Low amplitude

Monotoni

c
Trends

Fading

Decay of magnitude

Duration 100-1500 days

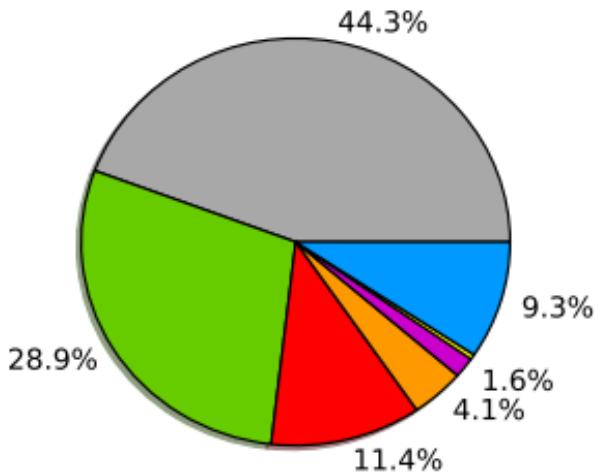
Duration 10-100 days

Trends

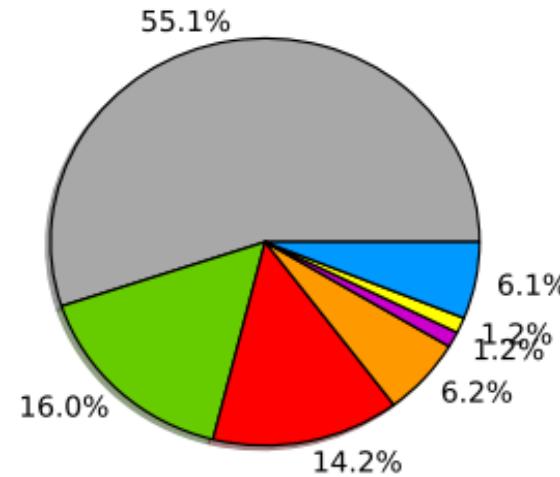
Duration up to 1000 days

Distribution of variability over the spectral type

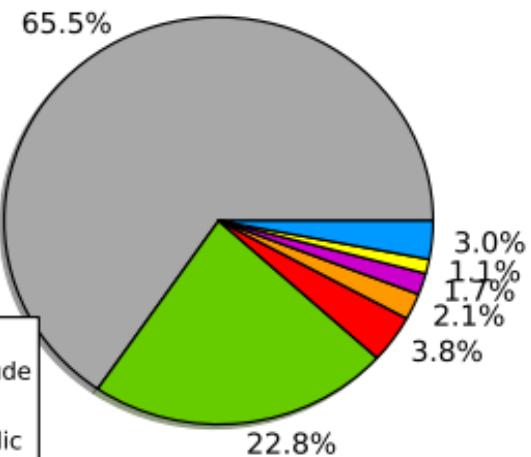
O Type (246)



Early B (2740)

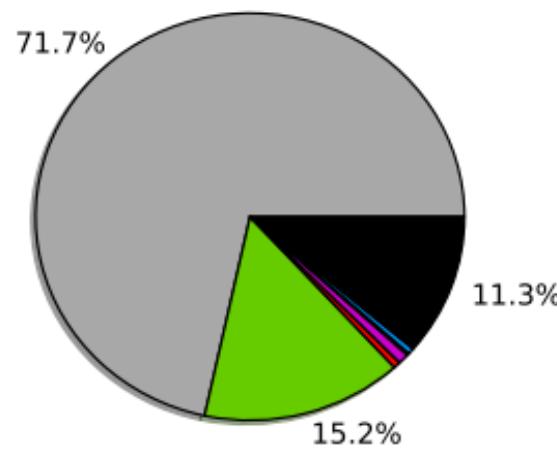


Late B (527)



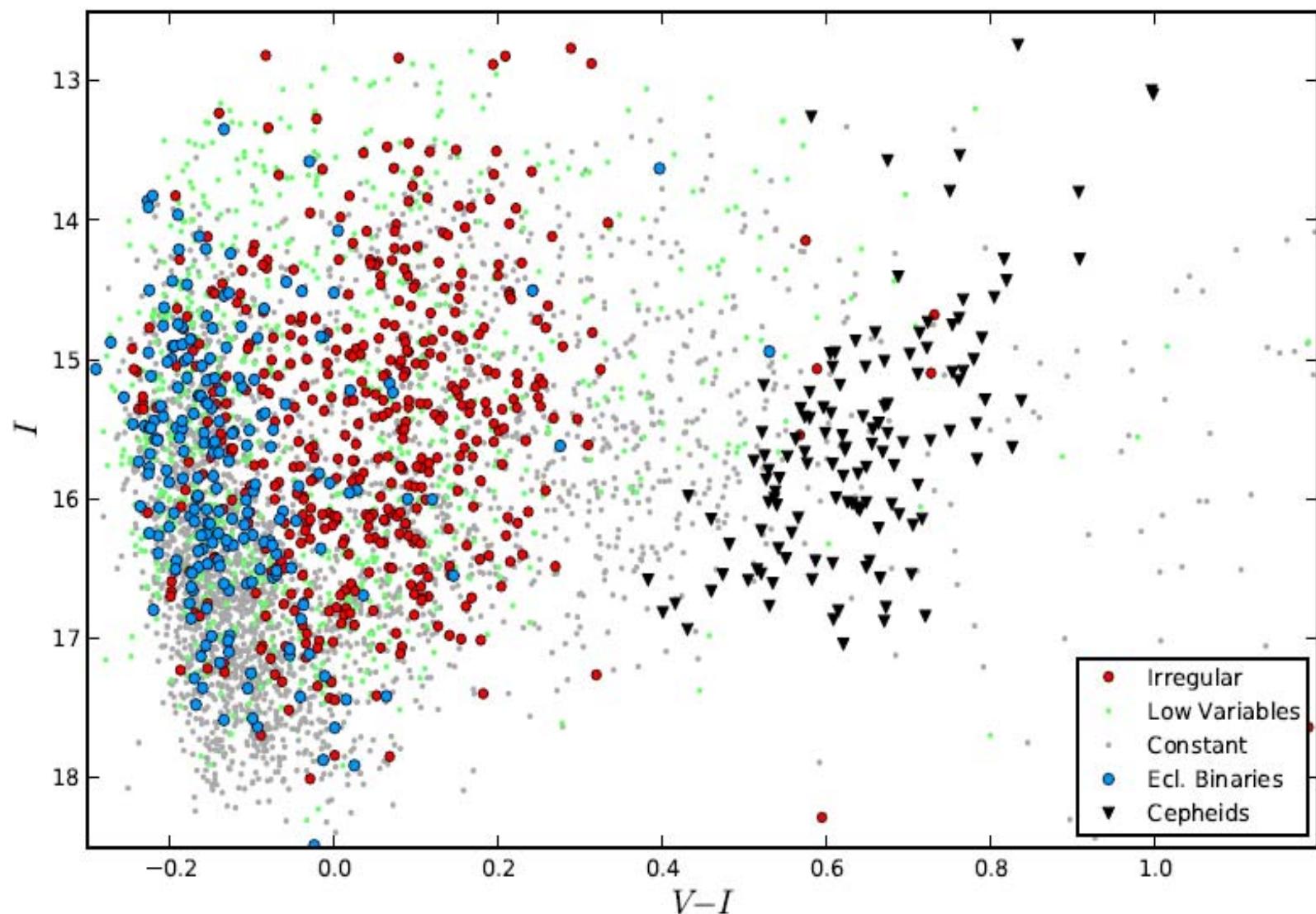
- Constant
- Low-amplitude
- Irregular
- Short periodic
- Long periodic
- Rotating Cand.
- Ecl. Binaries
- Cepheids

AFG (1101)



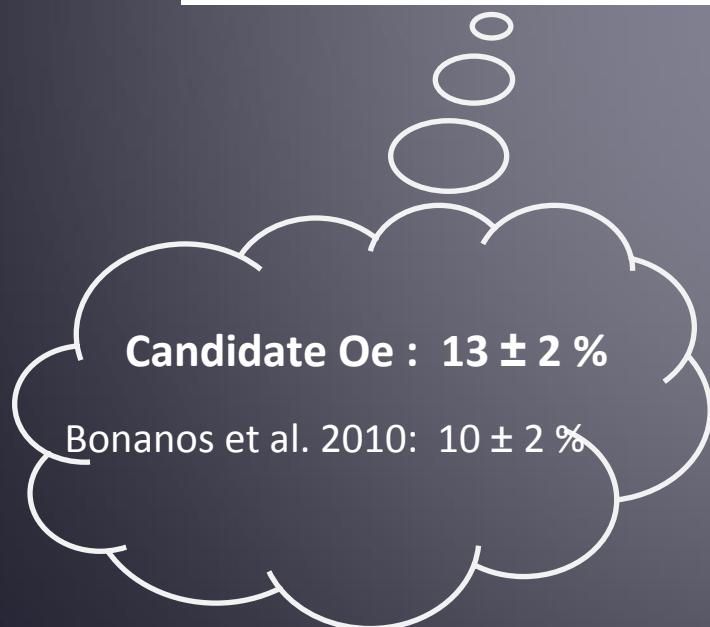
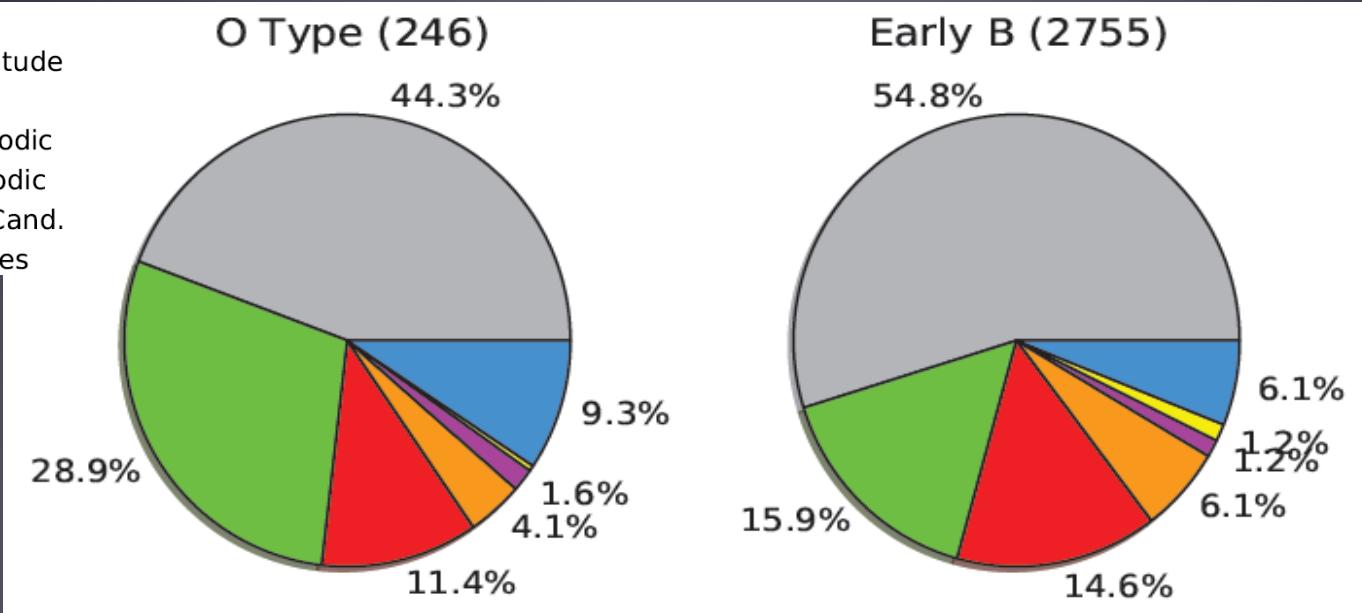
Color – magnitude diagram for variables

O-type
Early-B

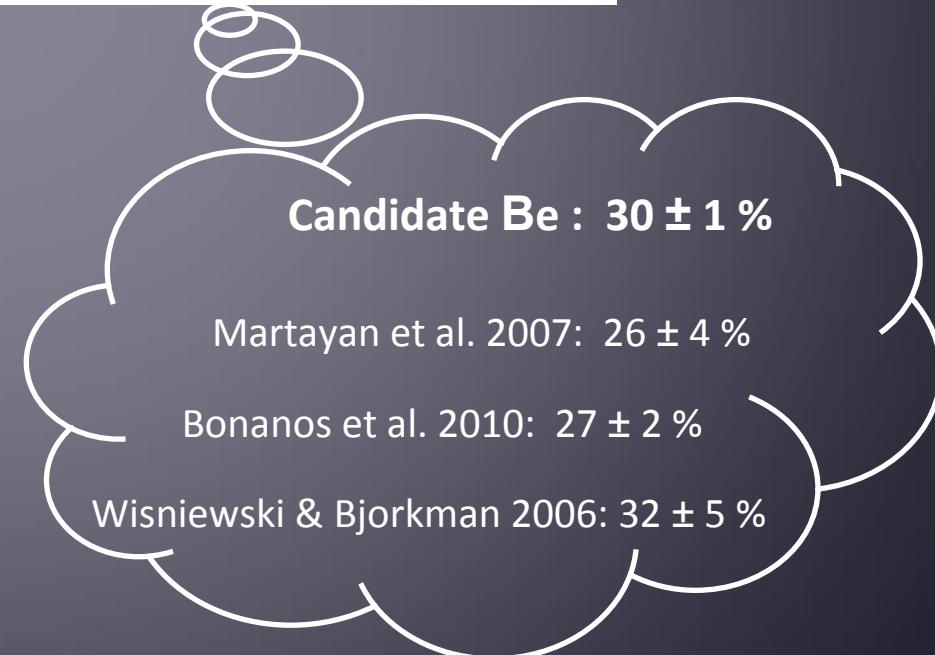


Candidate photometric Be stars

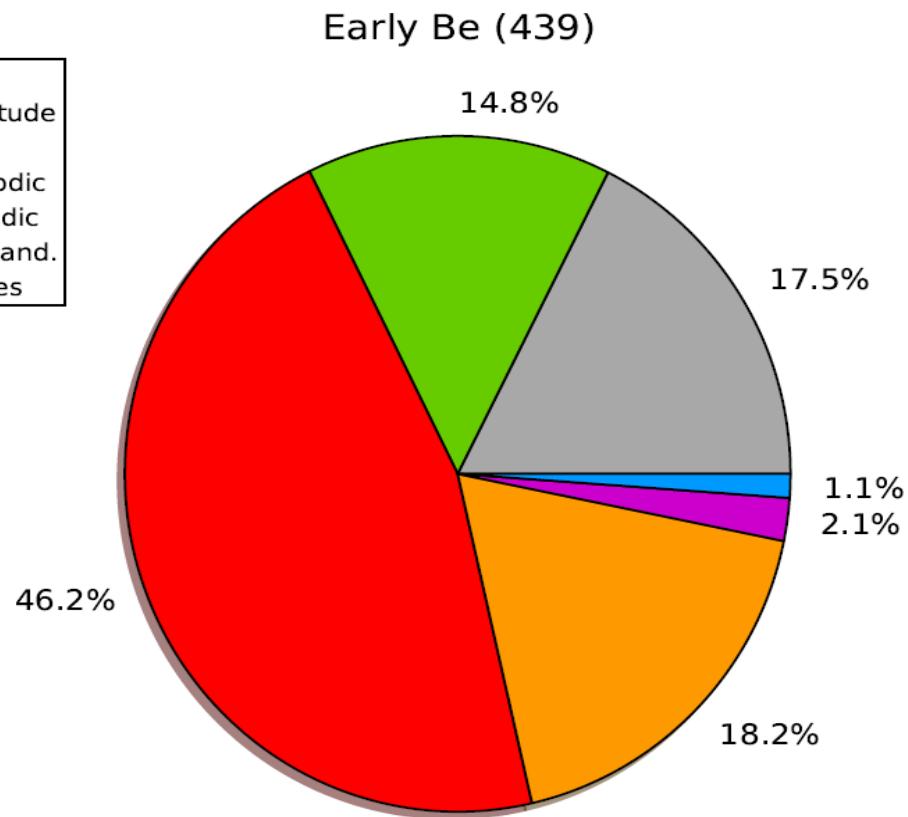
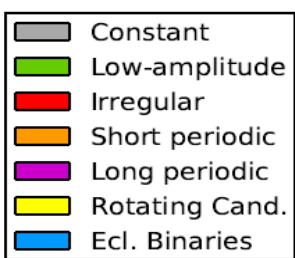
- Constant
- Low-amplitude
- Irregular
- Short periodic
- Long periodic
- Rotating Cand.
- Ecl. Binaries



Bonanos et al. 2010: $10 \pm 2 \%$

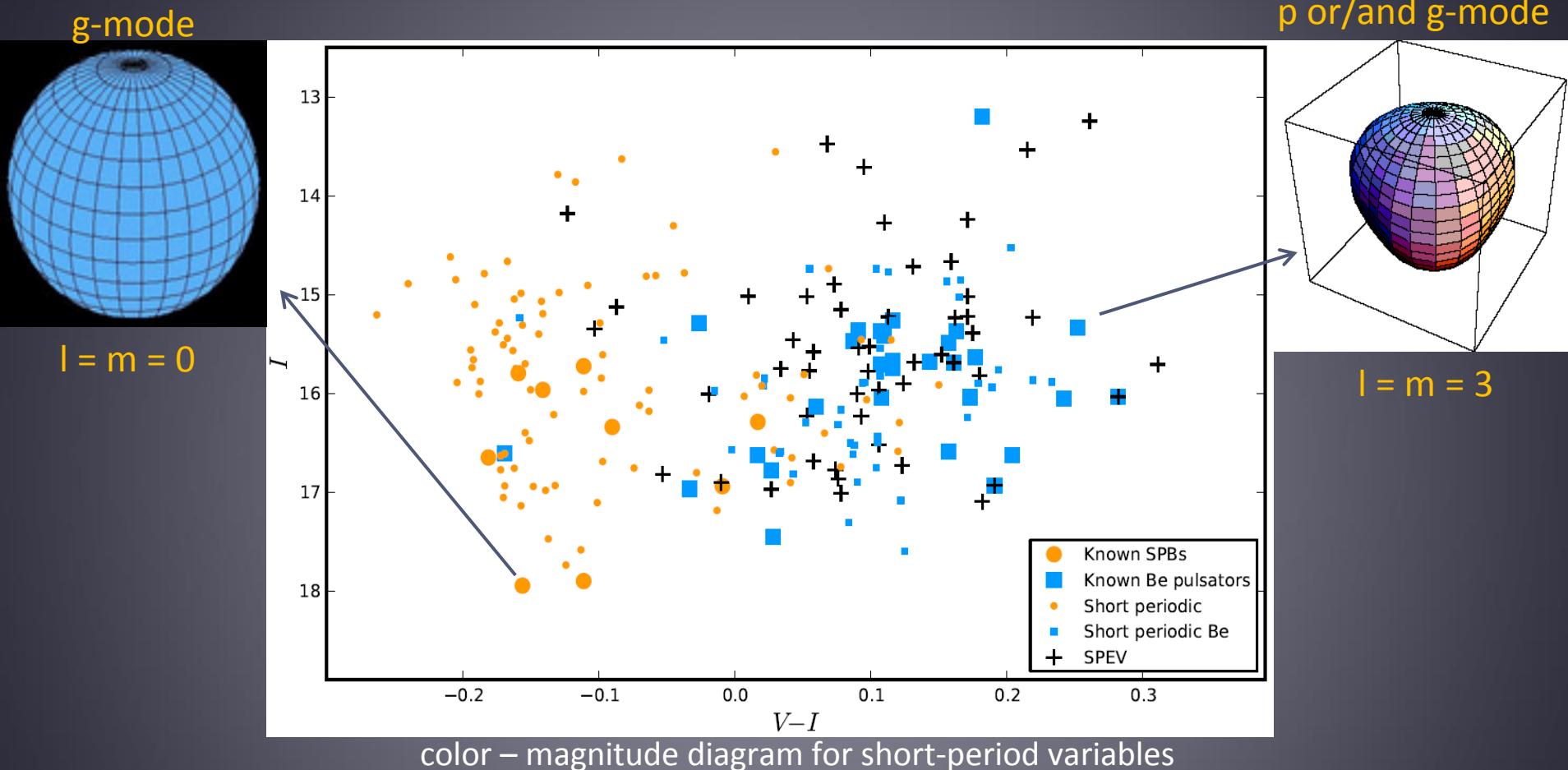


Photometric behavior of CONFIRMED Be stars



About 80% of Be stars present evident stochastic or periodic variability

Slowly Pulsating B stars (SPBs) and Be pulsators



- Several new candidate SPBs
- Short Periodic with Extra Variability ('SPEV') stars are shifted to redder colors
- available $vsini$ values (Martayan 07) establish 'SPEV's as fast rotators (Rivinius et al. 1998)

Conclusions

Studied stars	4650
'Constant'	2753
Low-amplitude stochastic	802
Irregular	471
Short/Long period	246
Eclipsing Binaries	211
Cepheids	124
Candidate rotating variables	43

Using OGLE-III long-term photometry, we

- discovered 108 eclipsing binaries with massive components.
- established long-term photometry as a tool for identifying Be stars. We identified ~220 irregular variables as candidate Be stars.
- provided evidence that critical rotation & pulsation are responsible for the SPEV phenomenon.

For more information

Variability of Spectroscopically Confirmed Massive Stars
in the Small Magellanic Cloud Using 8 Years of OGLE-III Data

**M. Kourniotis, A.Z. Bonanos, I. Soszynski, R. Poleski, A. Udalski,
M.K. Szymanski, M. Kubiak, G. Pietrzynski, L. Wyrzykowski, K. Ulaczyk,
S. Kozlowski, P. Pietrukowicz**

(to be submitted in AJ)

Thank You !