

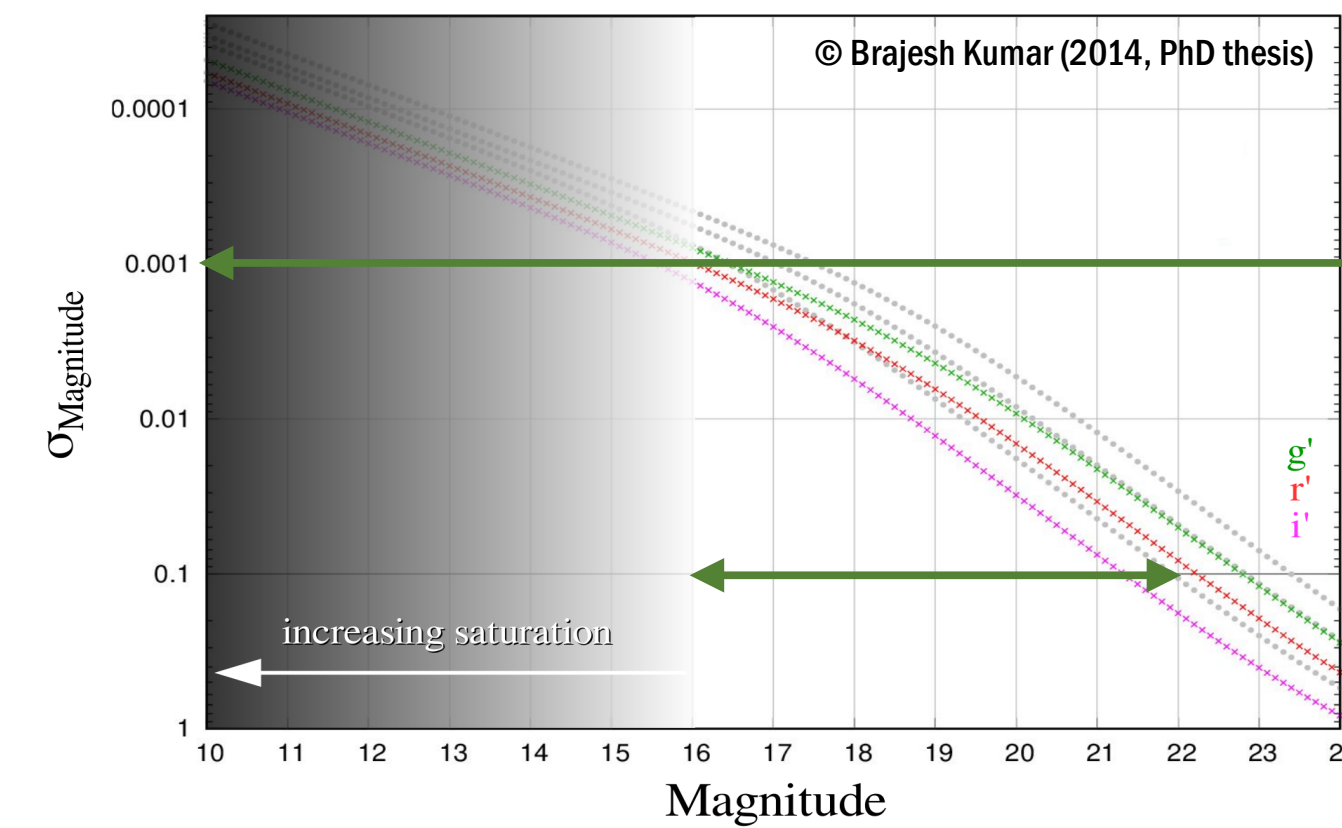
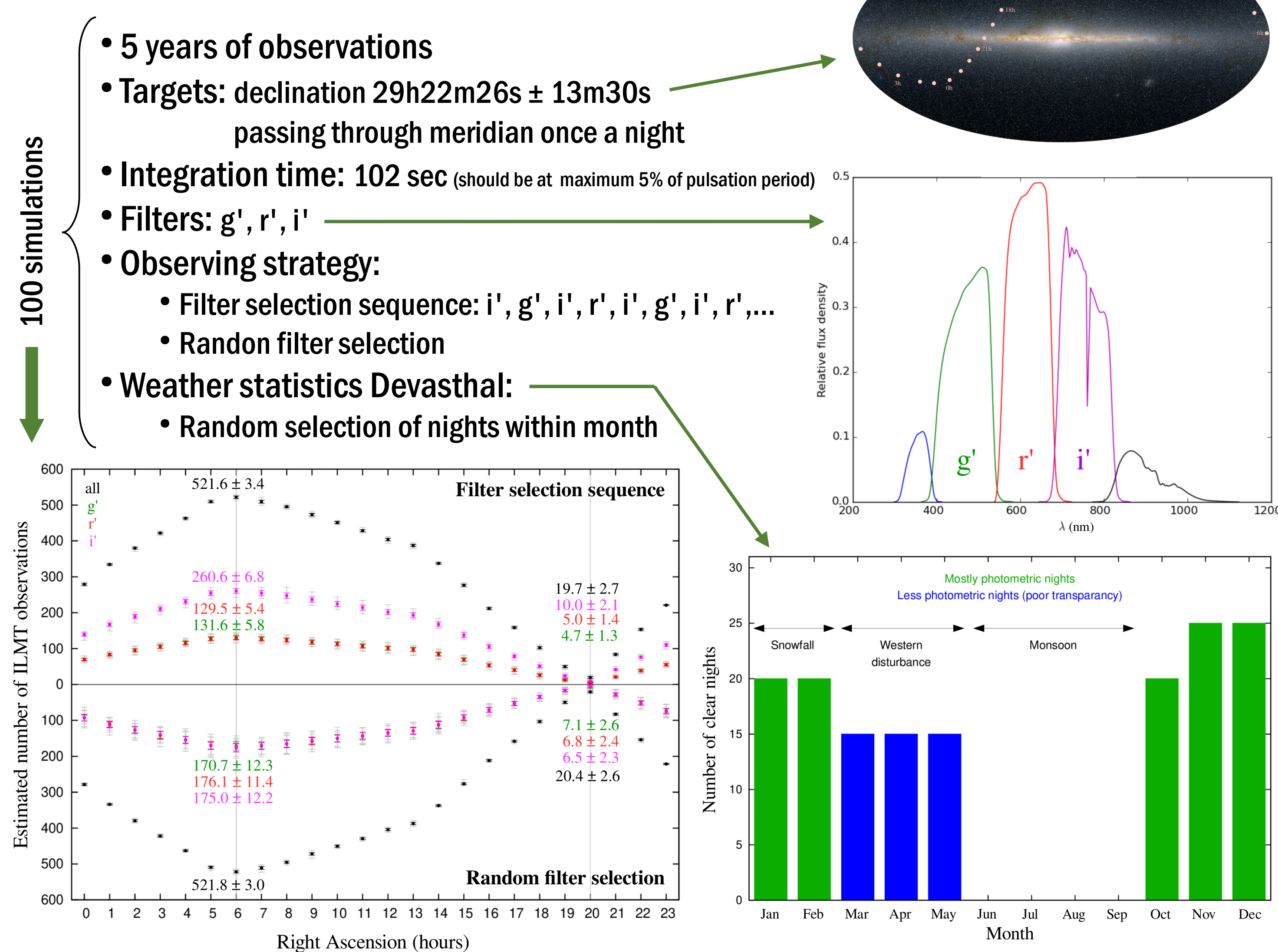


Prospects of pulsating stars studies with the 4-m ILMT

Peter De Cat (ROB, Belgium), Michaël De Becker (ULiège, Belgium), Brijesh Kumar (ARIES, India), Brajesh Kumar (ARIES, India), Jean Surdej (ULiège, Belgium)

The Hertzsprung-Russell diagram is covered with pulsating stars of many different kinds and flavours. Asteroseismology uses the pulsations of these stars to gain information about their interior, which is needed to improve our understanding of stellar evolution. During the last decade, asteroseismic studies have received an enormous boost thanks to space missions like MOST, CoRoT, Kepler/K2, and TESS. These missions have collected nearly uninterrupted photometric time-series with a precision down to a few micromag and a total time base of up to 4 years. TESS is the only one of these missions that is still collecting data and that is covering the largest part of the sky and hence will have targets in common with the ILMT strip. For which types of pulsating stars are the ILMT observations expected to give an added value to the already existing space-based observations? In this poster, we try to give an answer to this question.

Assumptions time series



Estimated error in magnitude

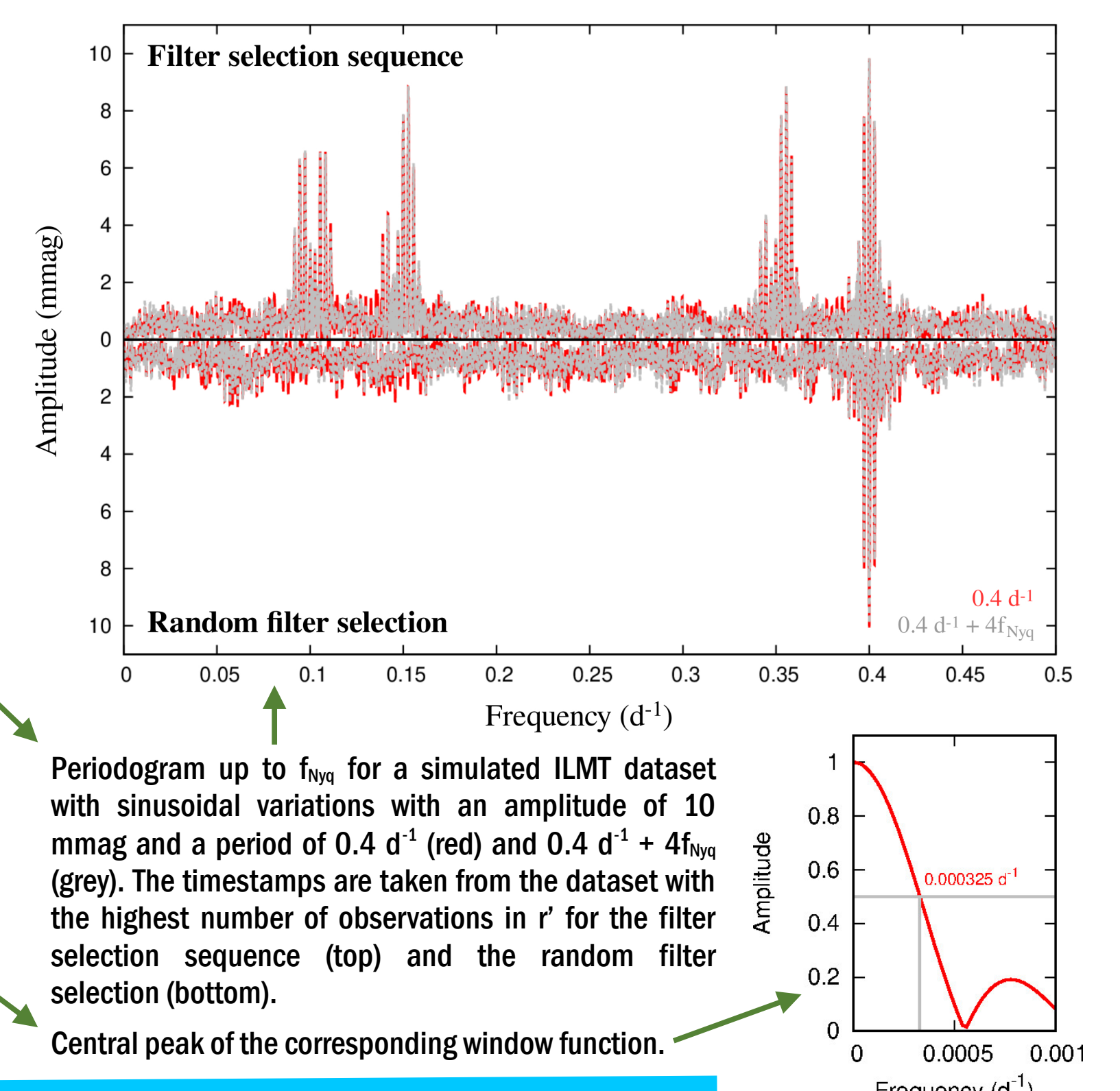
- For 1 observation: (102 sec in colour)
 - Pulsation amplitudes: above 0.001 mag
 - Magnitude range: roughly 16 – 22 mag
- For 3 observations combined: (306 sec in grey)
 - Advantage: gain of 0.5 mag in limiting magnitude
 - Disadvantage: loss of cadence in time series

Period analysis

- Detectable periods:
 - Longest period: 2T with T total timespan of observations
 - ILMT: T = 5 years $\Rightarrow \sim 10$ years
 - Shortest period: $1/f_{\text{Nyq}} = 2f_s^{-1}$ with f_s the sampling rate
 - ILMT: $f_s = 1$ sidereal day $\Rightarrow \sim 2$ days

- Aliasing:
 - Strong for filter selection sequence
 - Absent for random filter selection $\Rightarrow$ combine with other observatories

- Frequency resolution:
 - HWHM central peak window function



Pulsation class	Periods	Amplitudes	Brightness
Solar-like oscillators (Solar-like)	order of minutes	< 0.001 mag	
δ Scuti stars (δ Sct)	1 - 5 hours	< 0.9 mag	
γ Doradus stars (γ Dor)	0.3 - 3 days	< 0.03 mag	
rapidly oscillating Ap stars (roAp)	5 - 25 minutes	< 0.02 mag	
β Cephei stars (β Cep)	2 - 7 hours	< 0.04 mag	too bright
Slowly Pulsating B stars (SPB)	0.3 - 3 days	< 0.03 mag	too bright
Periodically Variable Supergiants (PVSG)	10 - 100 days	< 0.3 mag	too bright
RR Lyrae stars (RR Lyrae)	0.2 - 1 days	< 1 mag	
Cepheids (Cepheids)	0.1 - 200 days	< 1 mag	
Red Giant stars (RG)	1 hour - 4 days	< 0.001 mag	
Mira variables (Mira)	80 - 1000 days	> 2.5 mag	
Semi-Regular variables (SR)	20 - 2000 days	< 4 mag	
sub-dwarf B Variables (sdBV)	90 seconds - 4 hours	< 0.3 mag	
pulsating pre-white dwarfs (DOV)	5 - 85 minutes	< 0.3 mag	
pulsating white dwarfs (DBV/DAV)	100 - 1500 seconds	< 0.4 mag	

Requirements $\left\{ \begin{array}{l} > 0.5 \text{ hours} \\ 2 \text{ days} - 10 \text{ years} \end{array} \right.$

> 0.001 mag

roughly 16 - 22 mag

(Background image: One of the first images from the ILMT, consisting of an overlay of three individual observations in three different colours of a small portion of the sky containing the galaxy NGC 4274 as seen in the upper right corner)

Conclusions

The prospects are best:

- For pulsating stars with
 - Right ascension close to 6 hours
 - High enough magnitude (roughly 16 – 22 mag)
 - Long pulsation periods
 - Limit from integration time $\Rightarrow$ longer than 0.5 hours
 - Limits from period analysis $\Rightarrow$ 2 days – 10 years
 - Pulsation amplitudes above 0.001 mag
- For random selection of the filter (g', r' or i')
- If observations can be combined with other observatories

Semi-regular variables
Mira variables
Cepheids

Pulsating stars

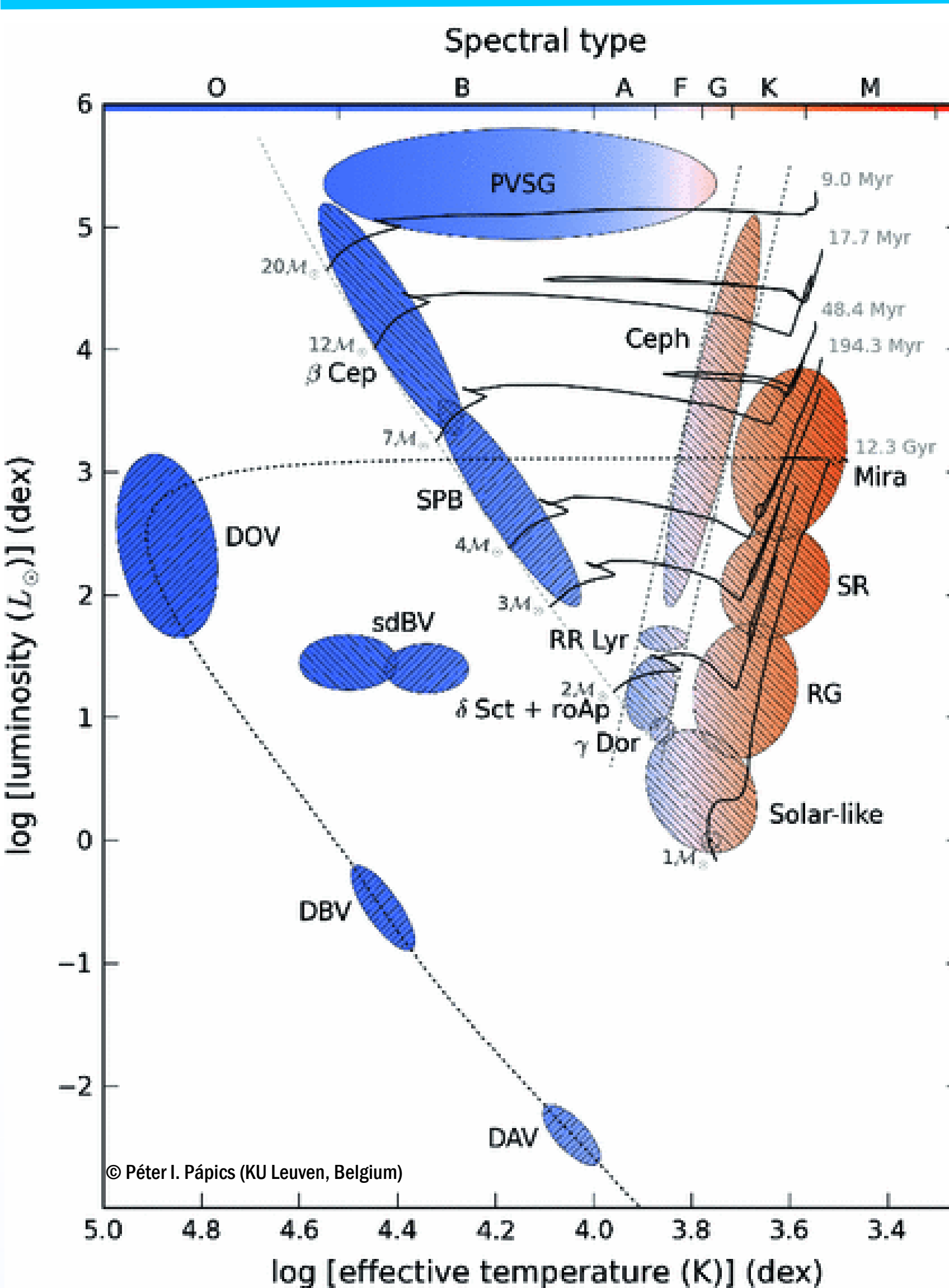
Hertzsprung-Russell diagram is covered with many different classes of pulsating stars (ellipses on the figure).

Each pulsation class has a typical:

- Range of pulsation periods (given in column “Periods” of the table)
- Range of pulsation amplitudes (maximum or minimum observed amplitude given in column “Amplitudes” of the table)

The table indicates the prospects to study them based on time series of single ILMT observations with standard techniques with respect to requirements on pulsation periods, pulsation amplitudes and brightness:

- White: no problems
- Light gray: some difficulties
- Dark gray: not possible



Contact:
• Peter De Cat (Peter.DeCat@oma.be)
<https://aa.oma.be/>