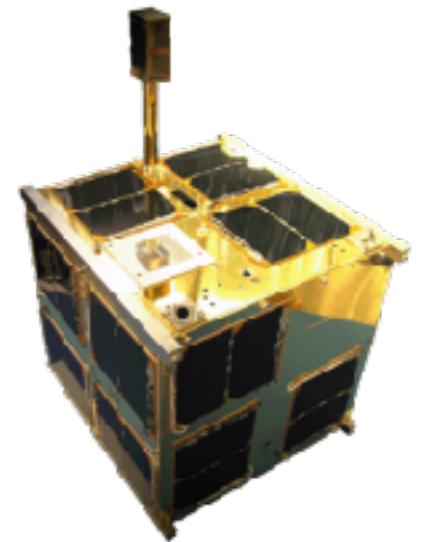


BRITE-CONSTELLATION AND ITS SCIENTIFIC HIGHLIGHTS



*Shoebox-sized satellites
for variable star research*



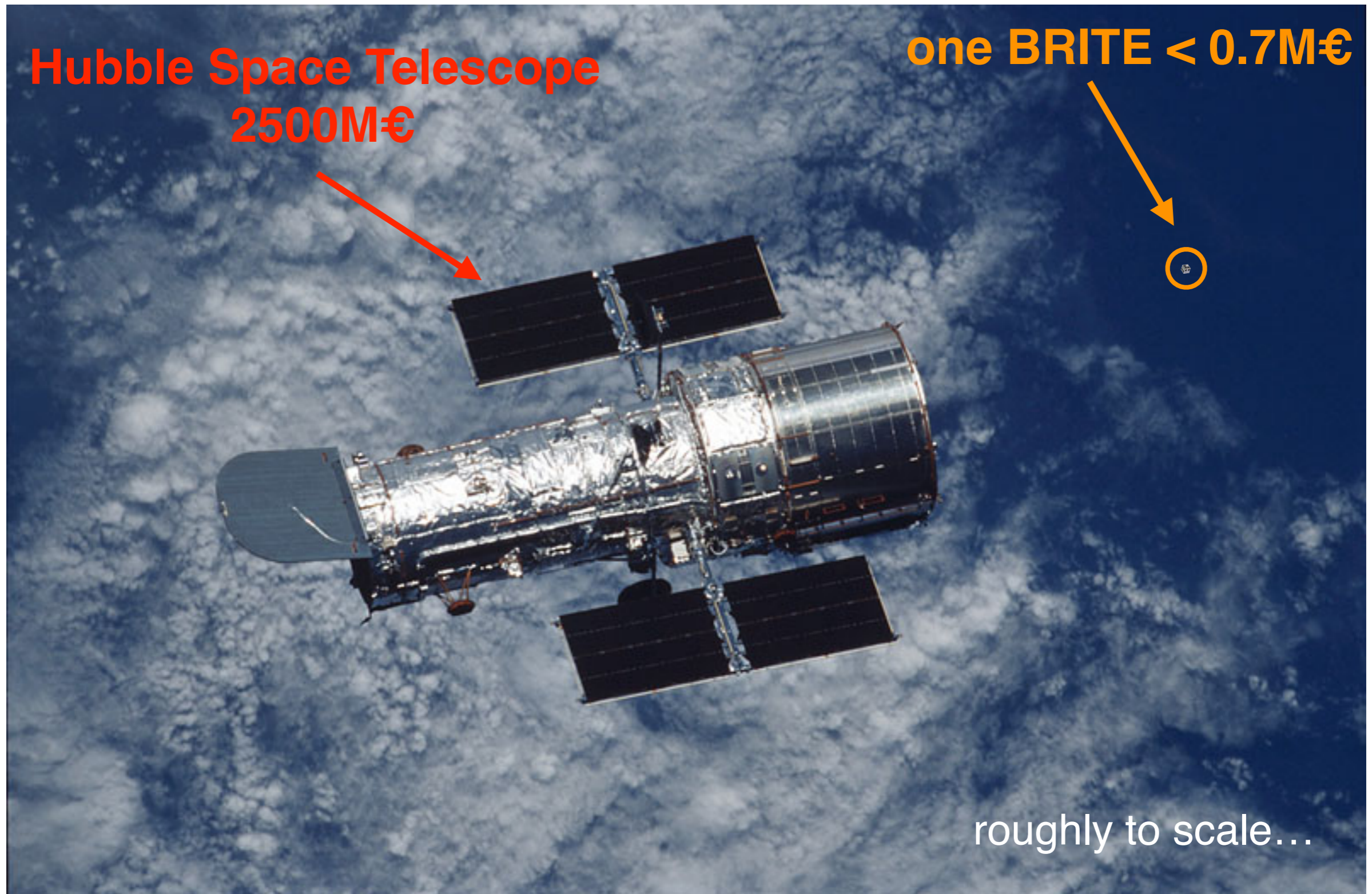
Konstanze Zwintz

Institute for Astro- and Particle Physics, University of Innsbruck

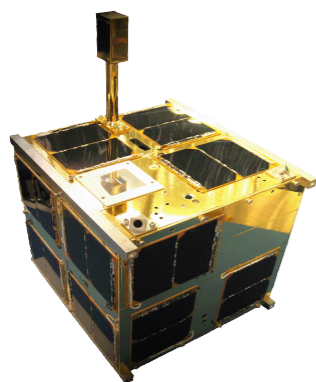
&

B. Pablo, D. Baade, M. Kenworthy, D. Reese, T. Van Reeth, R. Kuschnig, and the *BRITE-Constellation Executive Science Team (BEST)*

SPACE TELESCOPES

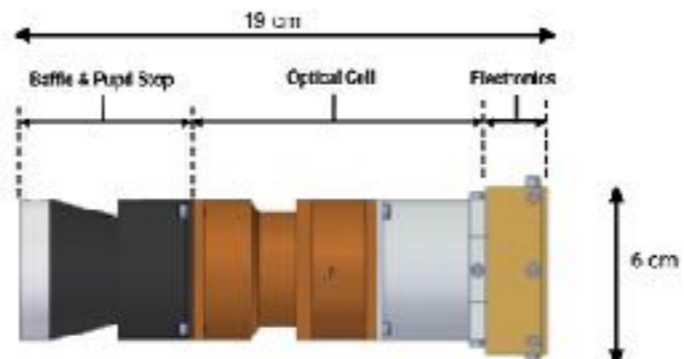


THE BRITE NANO-SATELLITES



mass: 7 kg

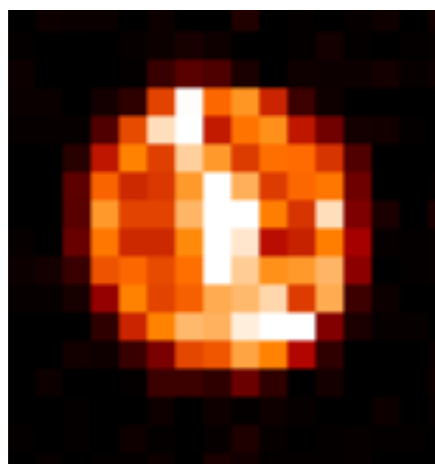
size: 20 x 20 x 20 cm³



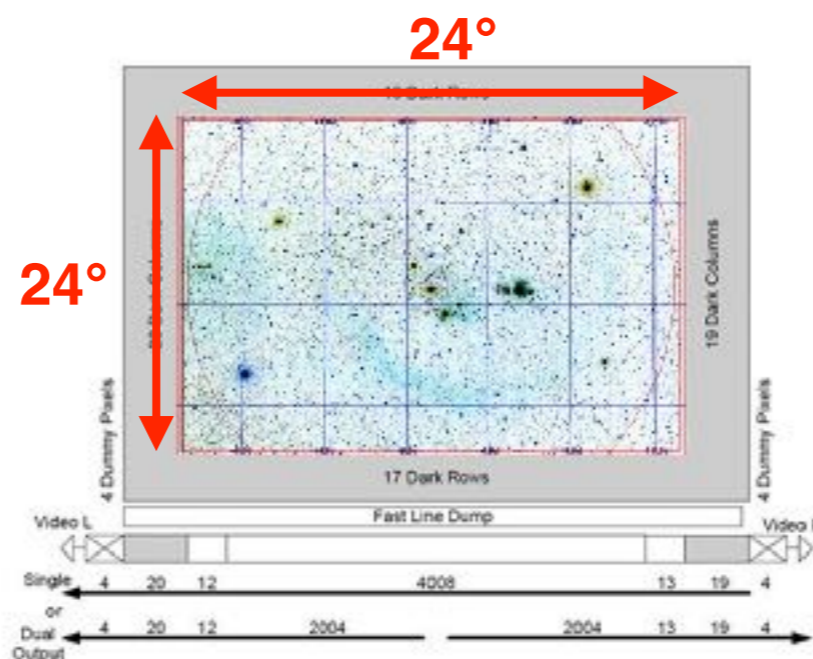
telescope diameter: 3cm



3-axes stabilization



pixel size: 9 μ m x 9 μ m



24° x 24° field of view:
fits Orion completely



power consumption:
5 - 10 W

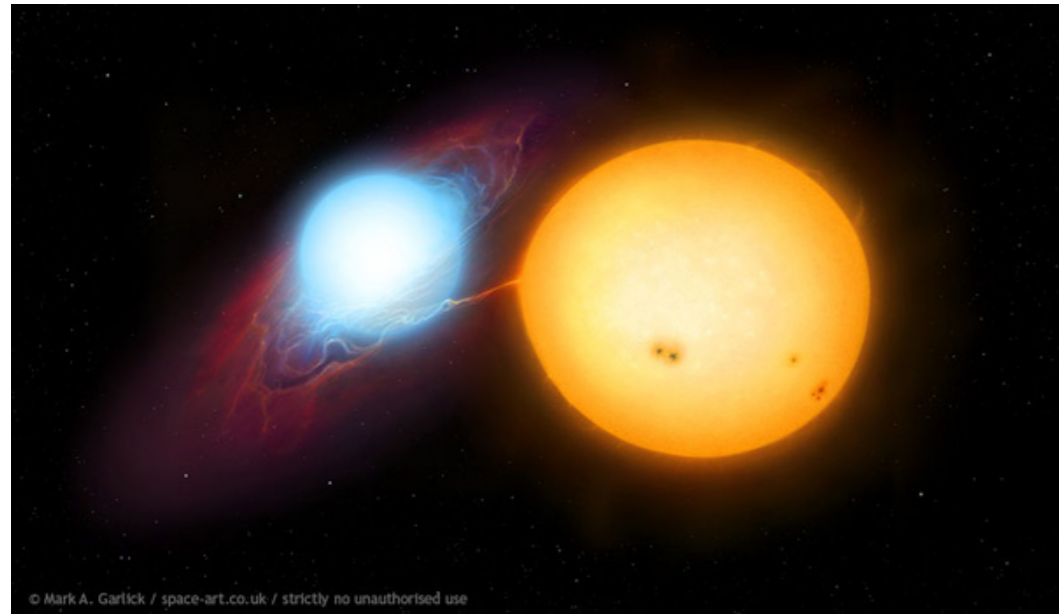
BRITE-CONSTELLATION

Country	Satellite Name	ID	Launch	Orbit-P(min)	Filter
AUT	UniBRITE	UBr	2013-02-25	100.37	red
AUT	BRITE-Austria 'TUG-SAT-1'	BAb	2013-02-25	100.36	blue
POL	BRITE-PL2 'Heweliusz'	BHr	2014-08-19	97.10	red
POL	BRITE-PL1 'Lem'	BLb	2013-11-21	99.57	blue
CAN	BRITE-CA1 'Toronto'	BTr	2014-06-19	98.24	red
CAN	BRITE-CA2 'Montreal'	BMb	2014-06-19	n/a	blue

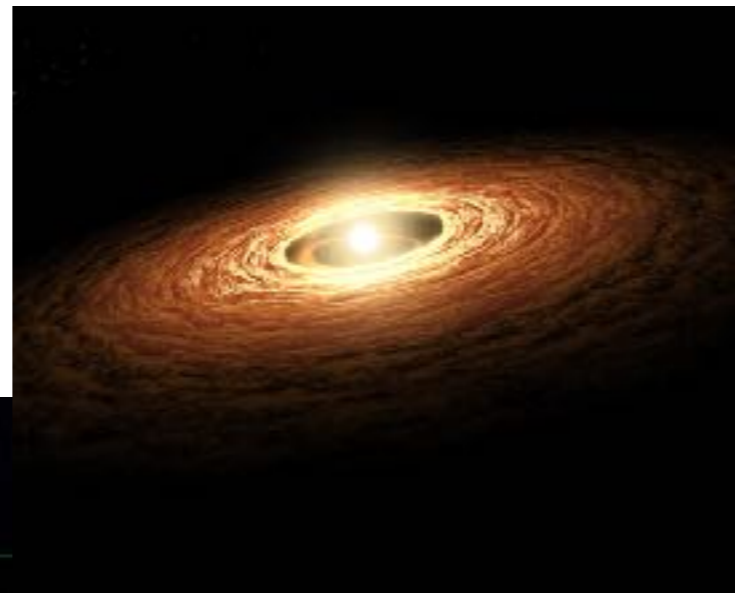
**Goal: Measuring the light of
15 - 30 brightest, most luminous stars
per field for up to half a year continuously**

BRIGHTNESS VARIATIONS OF STARS

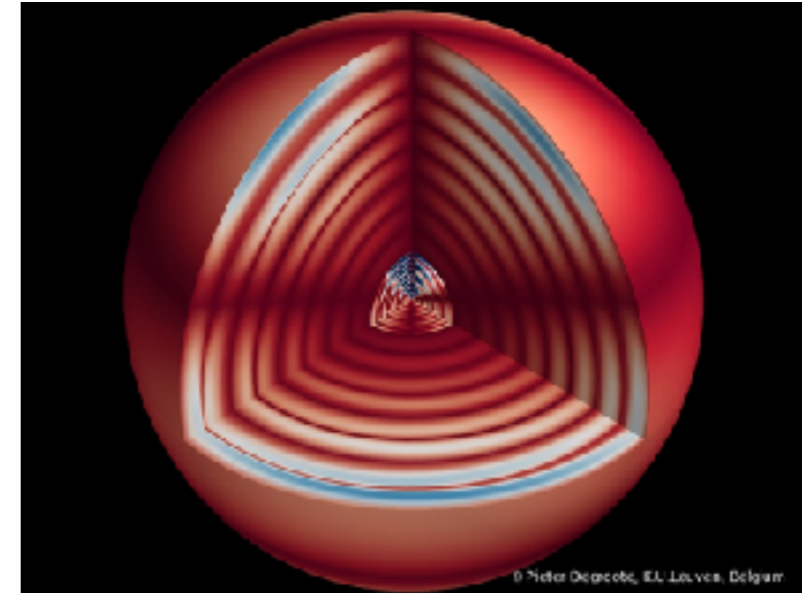
Binaries



Young stars /
Stars with disks



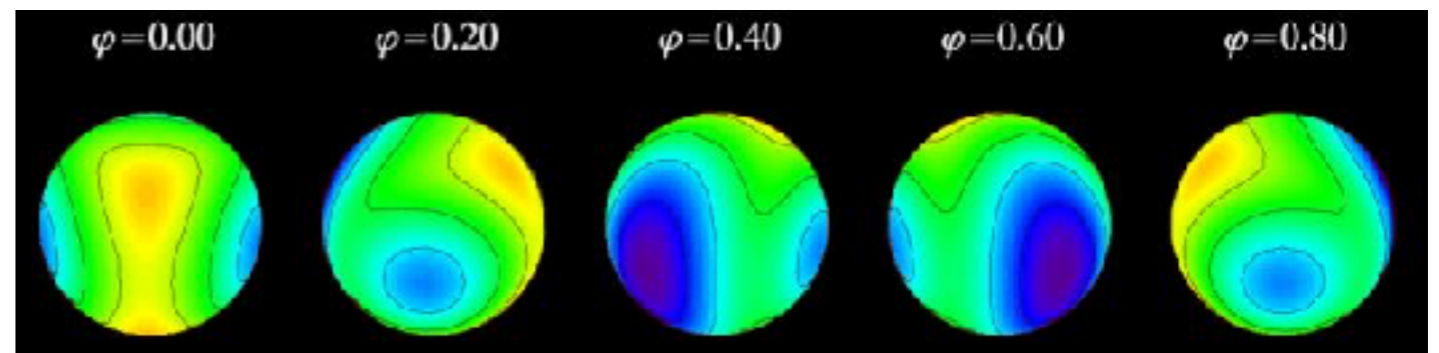
Pulsating stars



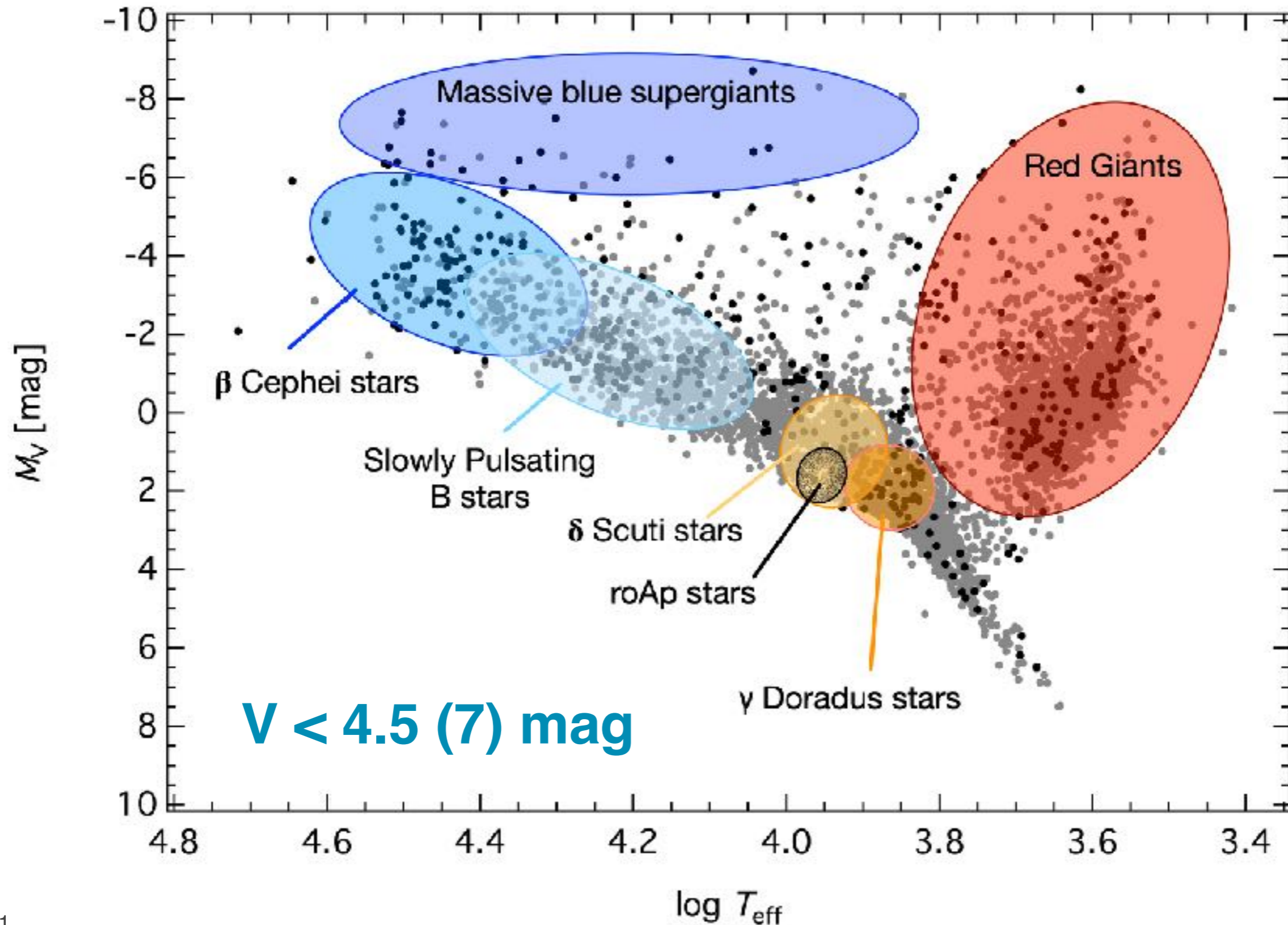
Planetary Transit



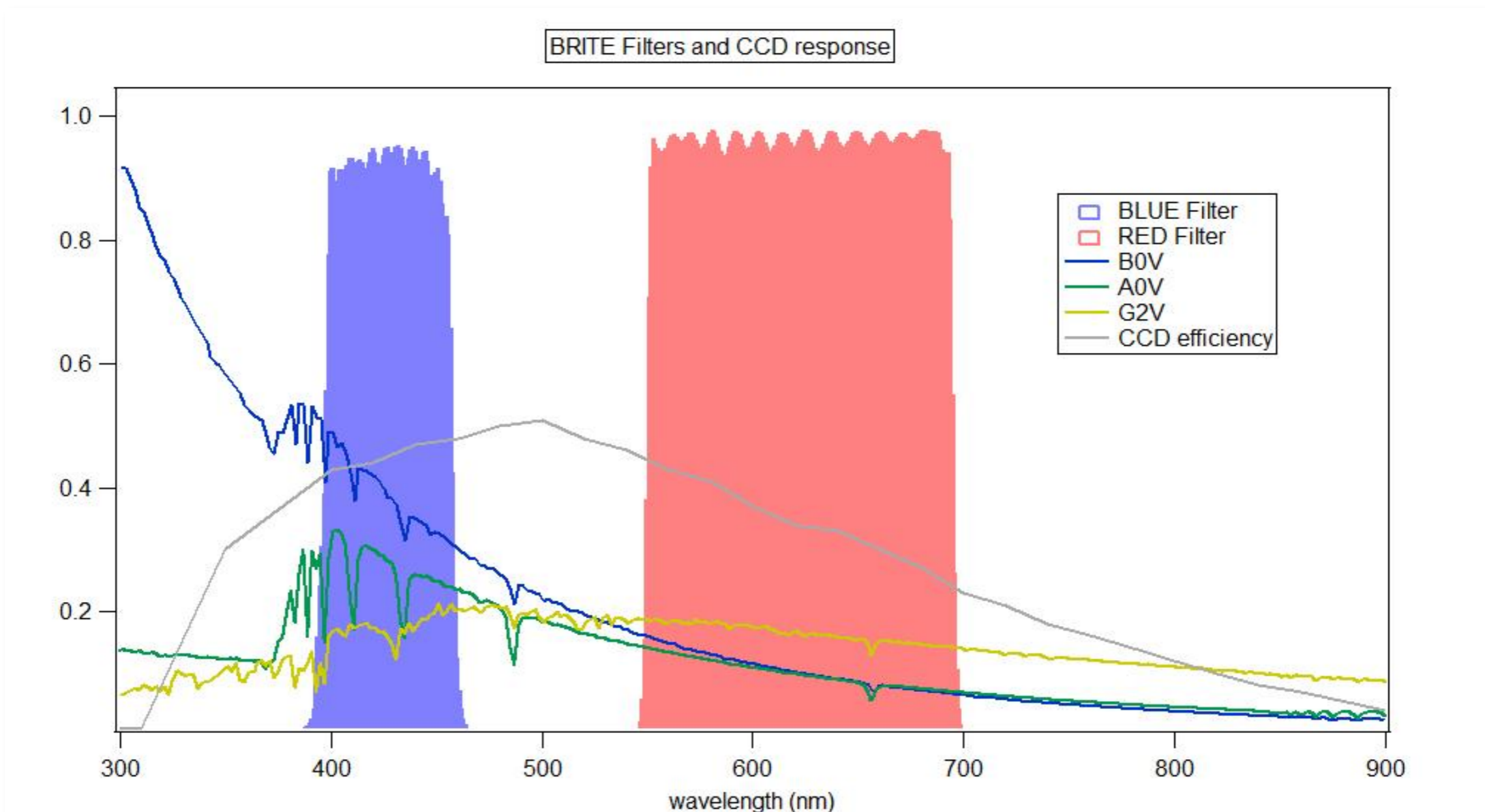
Rotating stars: spots



BRITE-CONSTELLATION SCIENCE



BRITE FILTERS



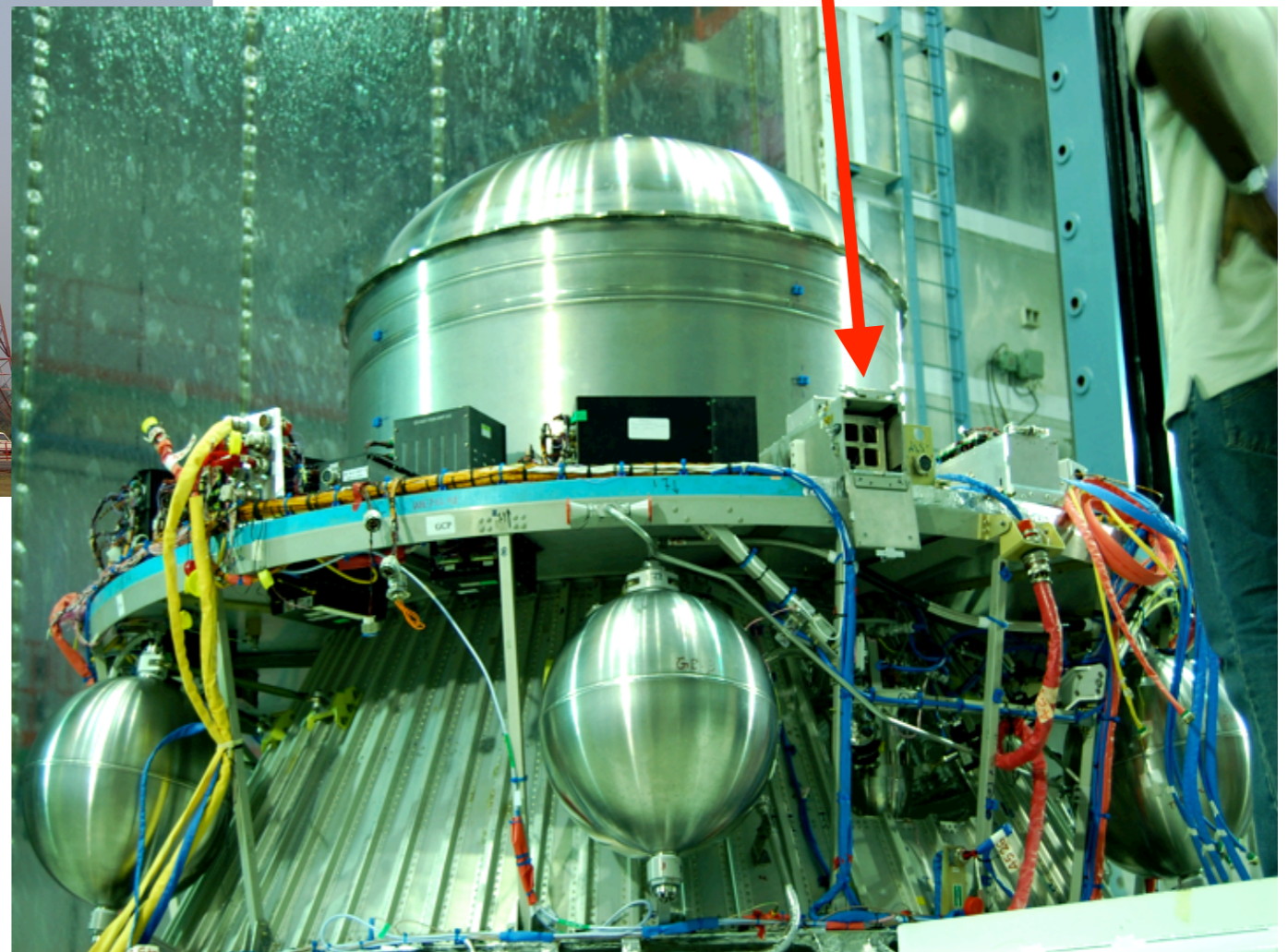
BRITE Blue: 400 - 450nm

BRITE Red: 550 - 700nm

INTO SPACE...

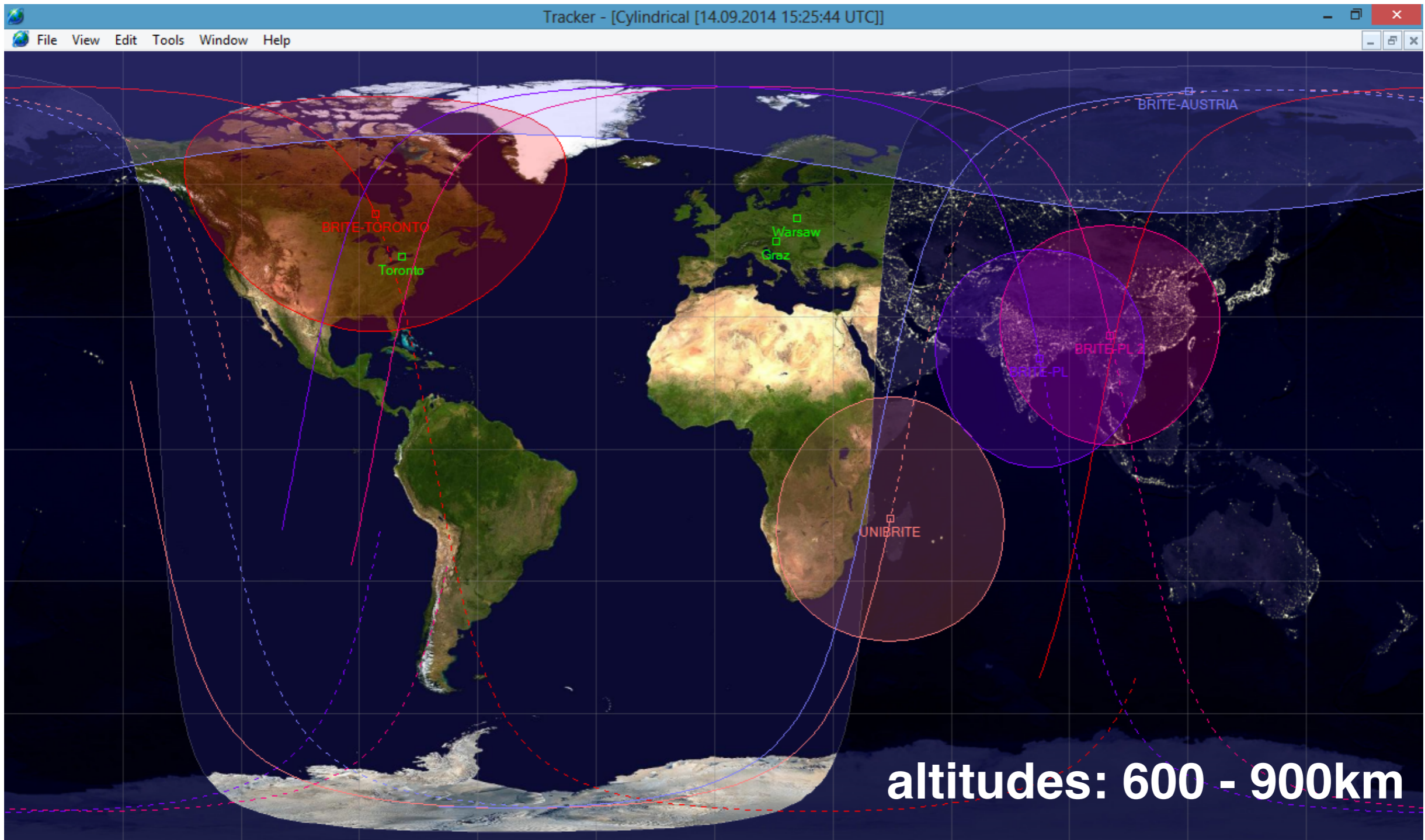


“BRITE in the box”



Feb 25, 2013:
Launch of the Austrian
BRITEs from India

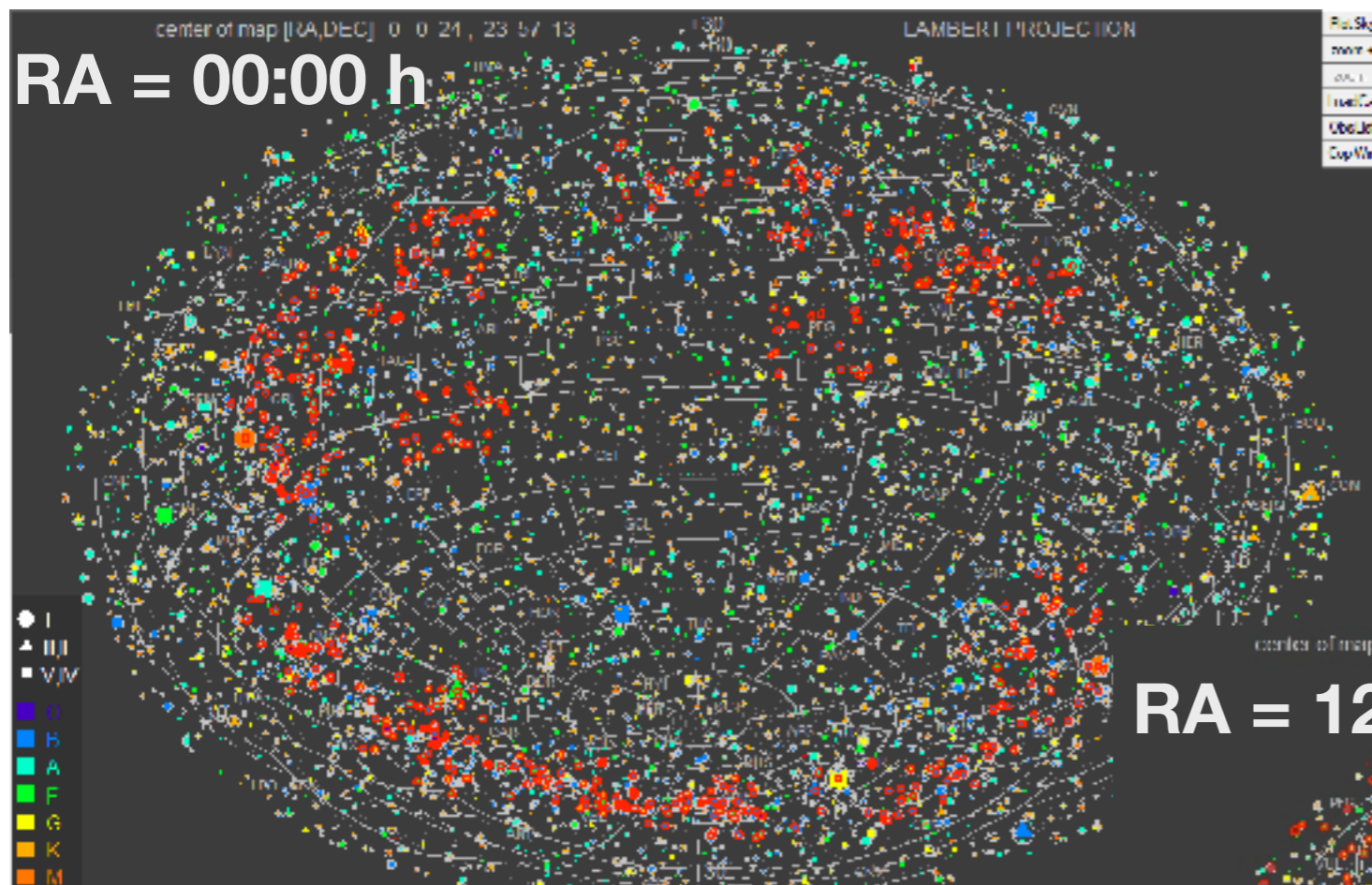
ALL BRITES ARE IN POLAR LEOs



OBSERVING STRATEGY

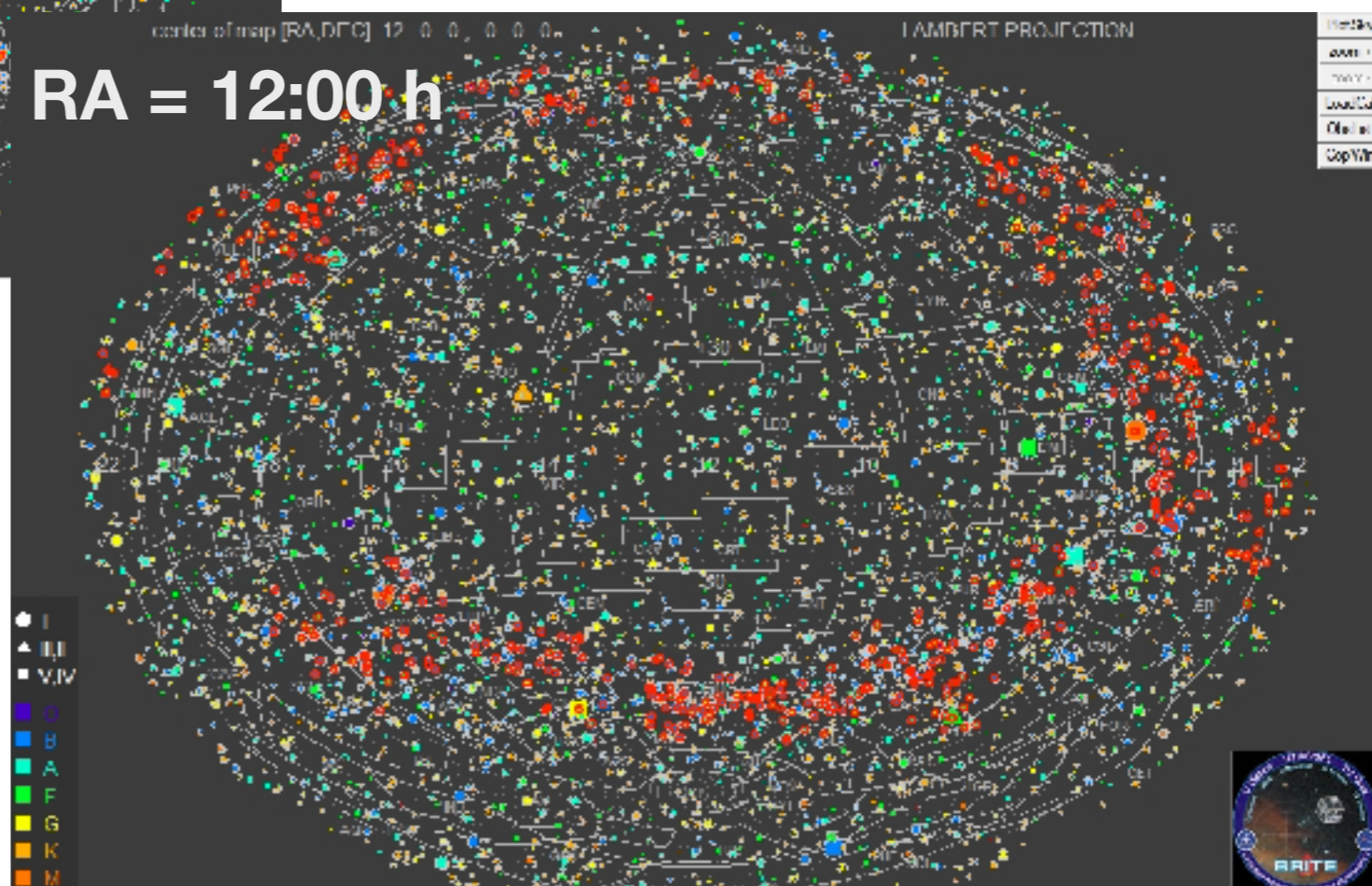
- ◆ Time series photometry for some of the **brightest, most massive and luminous stars** in the sky
- ◆ **15 - 30 stars per observing field** at once
- ◆ Time bases of **up to half a year** for a single observing campaign
- ◆ Observations during **15 - 30 minutes per orbit**
- ◆ 11 Megapixel CCD with 30 arcsec / pixel
 - selected **rasters** are read out

THE BRITE SKY



**625 stars (multiple times)
in 42 completed fields**

**Brightest: Canopus V = -0.72 mag
Faintest: HD 96265 V = 8.03 mag**



**BRITE Legacy Fields:
observed multiple times
→ time bases of years**

BRITE TARGET STATISTICS

Total: 526 stars

O: ~5%

B: ~50%

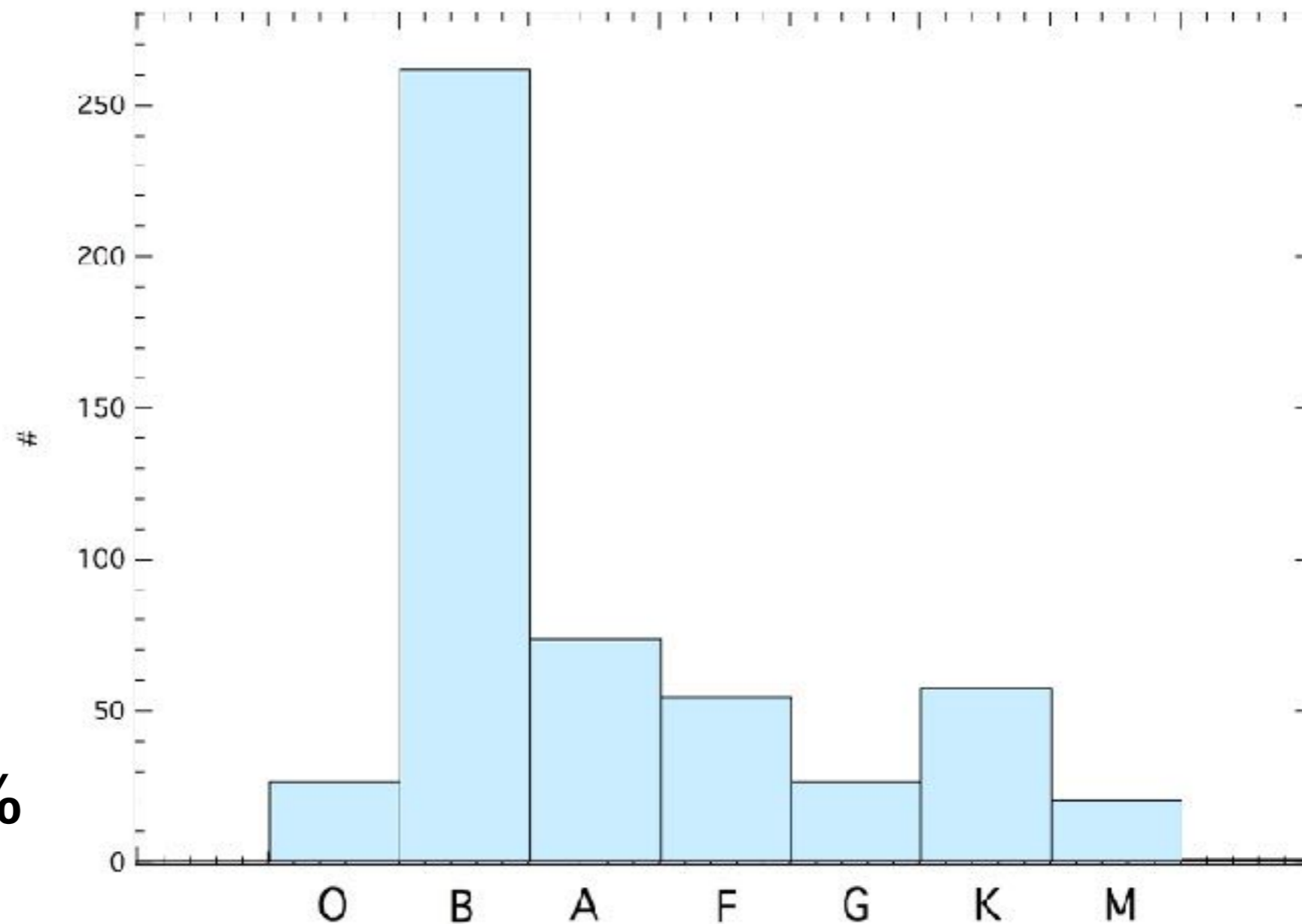
A: ~14%

F: ~11%

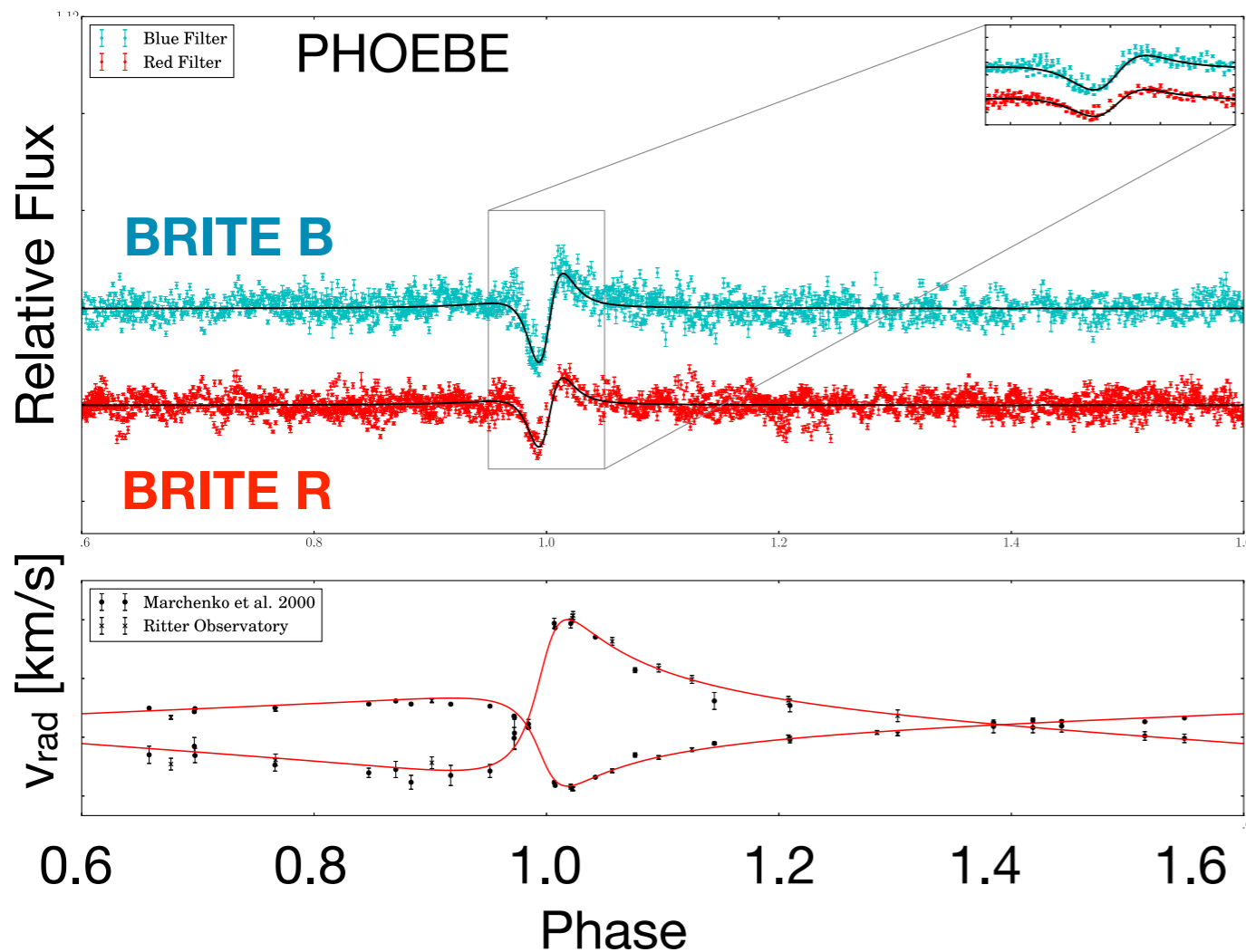
G: ~5%

K: ~11%

M & cooler: ~4%



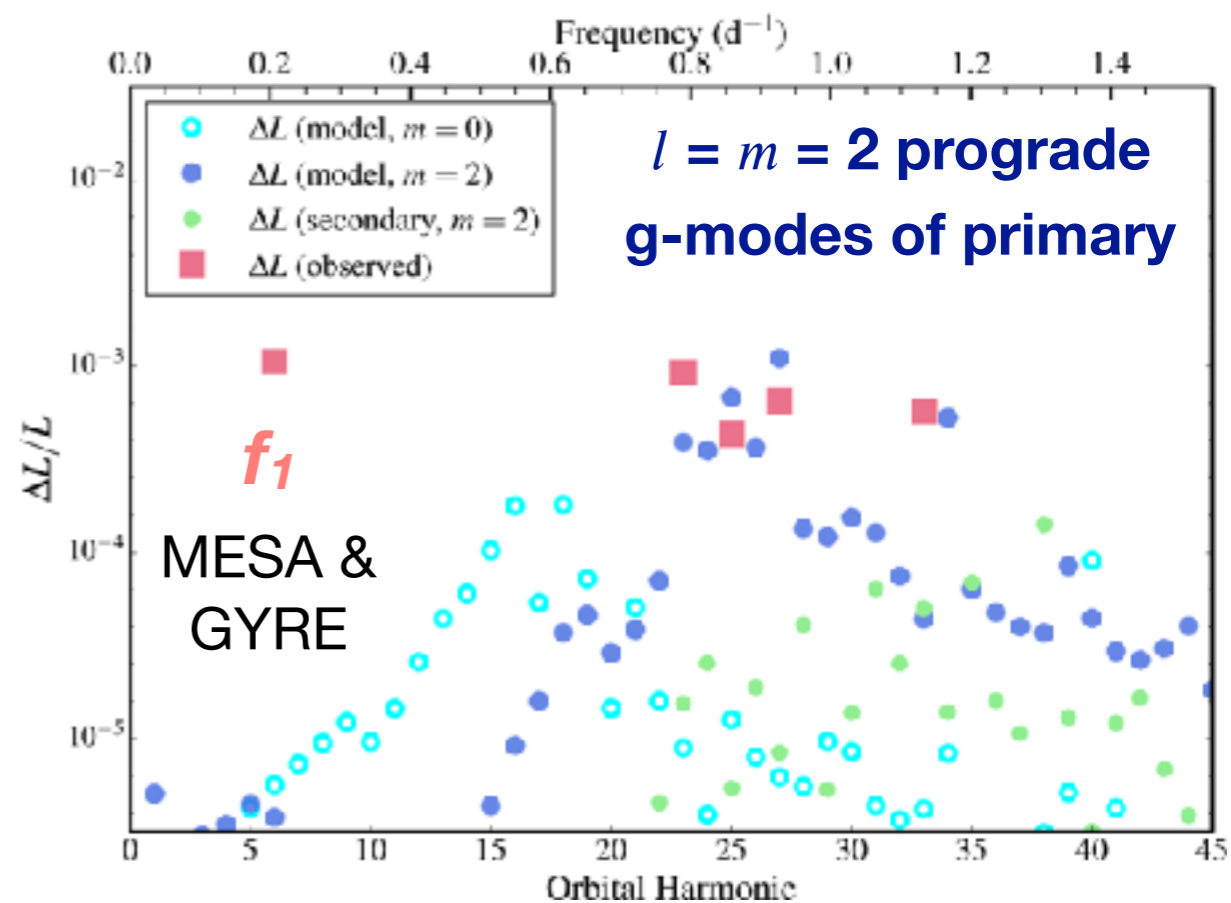
HIGHLIGHT I: A MASSIVE HEARTBEAT



Pablo et al. (2017)

ι Orionis:

- ▶ O9 III + B1 III/IV
- ▶ high eccentricity $e = 0.764$
- ▶ short $P_{\text{orb}} = 29.13376\text{d}$



HIGHLIGHT II: BE STARS

25 Orionis:

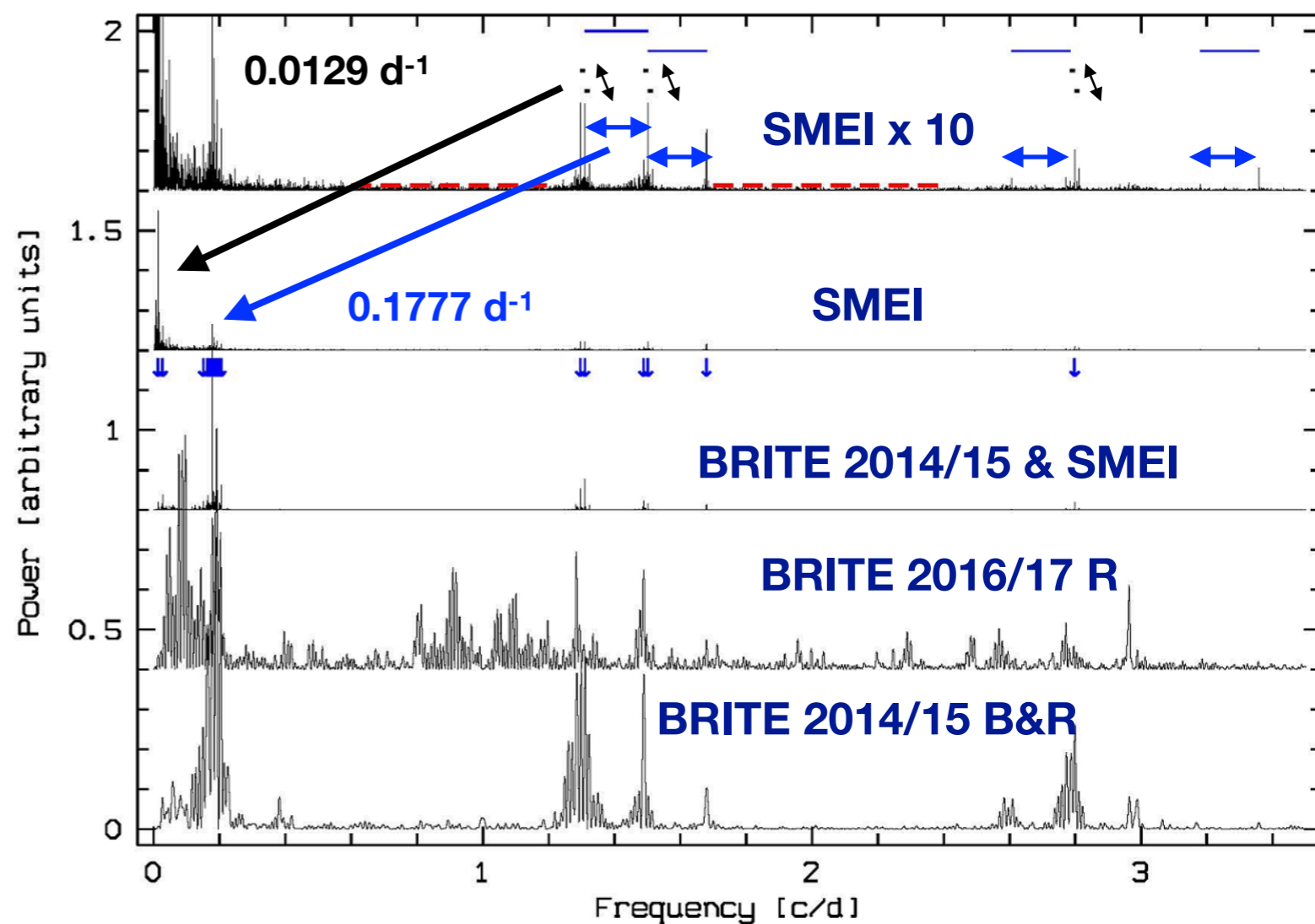
- ▶ B1 Vne
- ▶ $V = 4.96$ mag

◆ Excess angular momentum in Be stars

- regular pulsation-driven ejection of matter

◆ Key: large-amplitude difference frequencies of non-radial pulsation g-modes

Difference frequencies



Baade et al. (2019, in prep.)

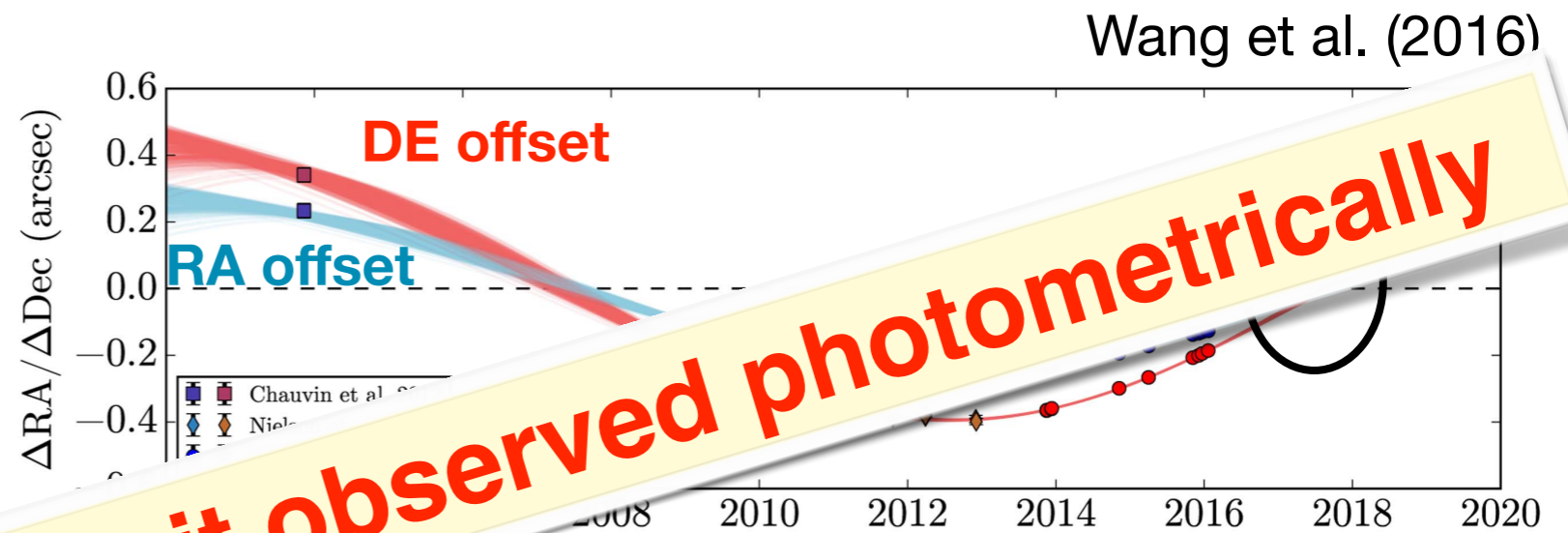
HIGHLIGHT III: THE β PICTORIS SYSTEM

β Pictoris:

- ▶ $T_{\text{eff}} = 8200 \pm 150$ K
- ▶ Age ~ 23 Myr
- ▶ δ Scuti pulsator



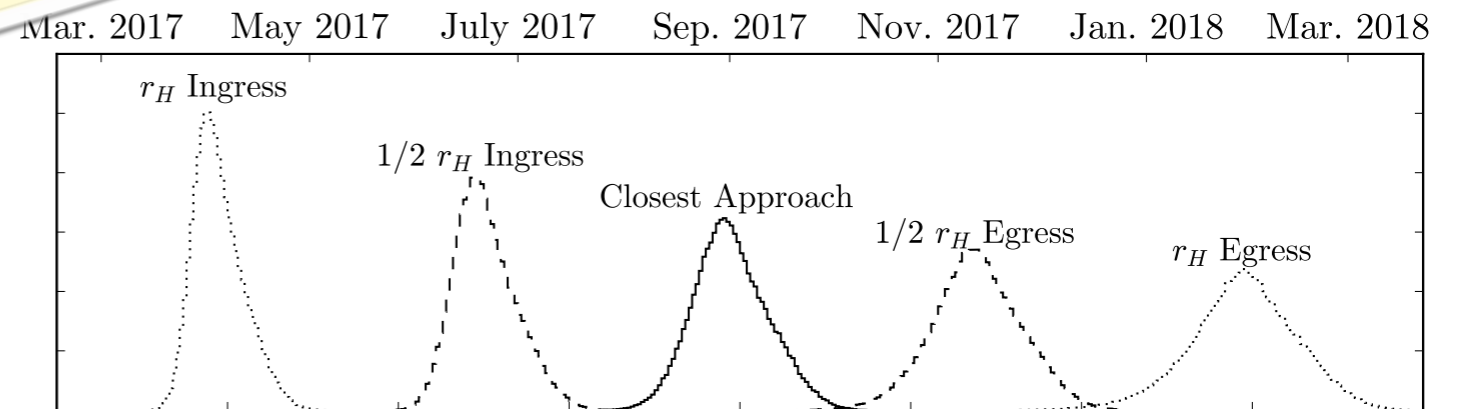
Grange et al. (2014)



▶ **No Hill sphere transit observed photometrically**

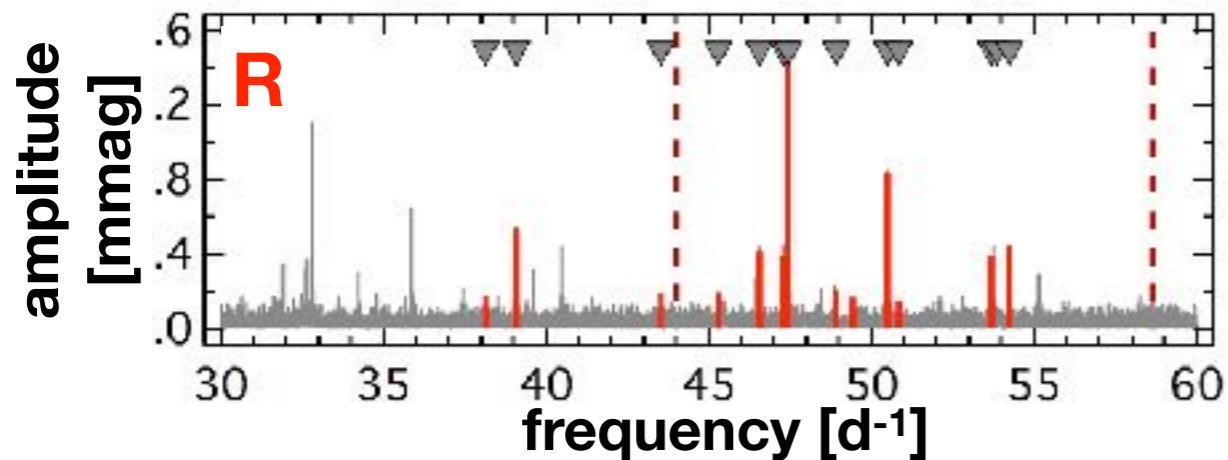
β Pictoris b:

- ▶ $M = 10 M_{\text{jupiter}}$
- ▶ semi-major axis: 8 - 13 AU



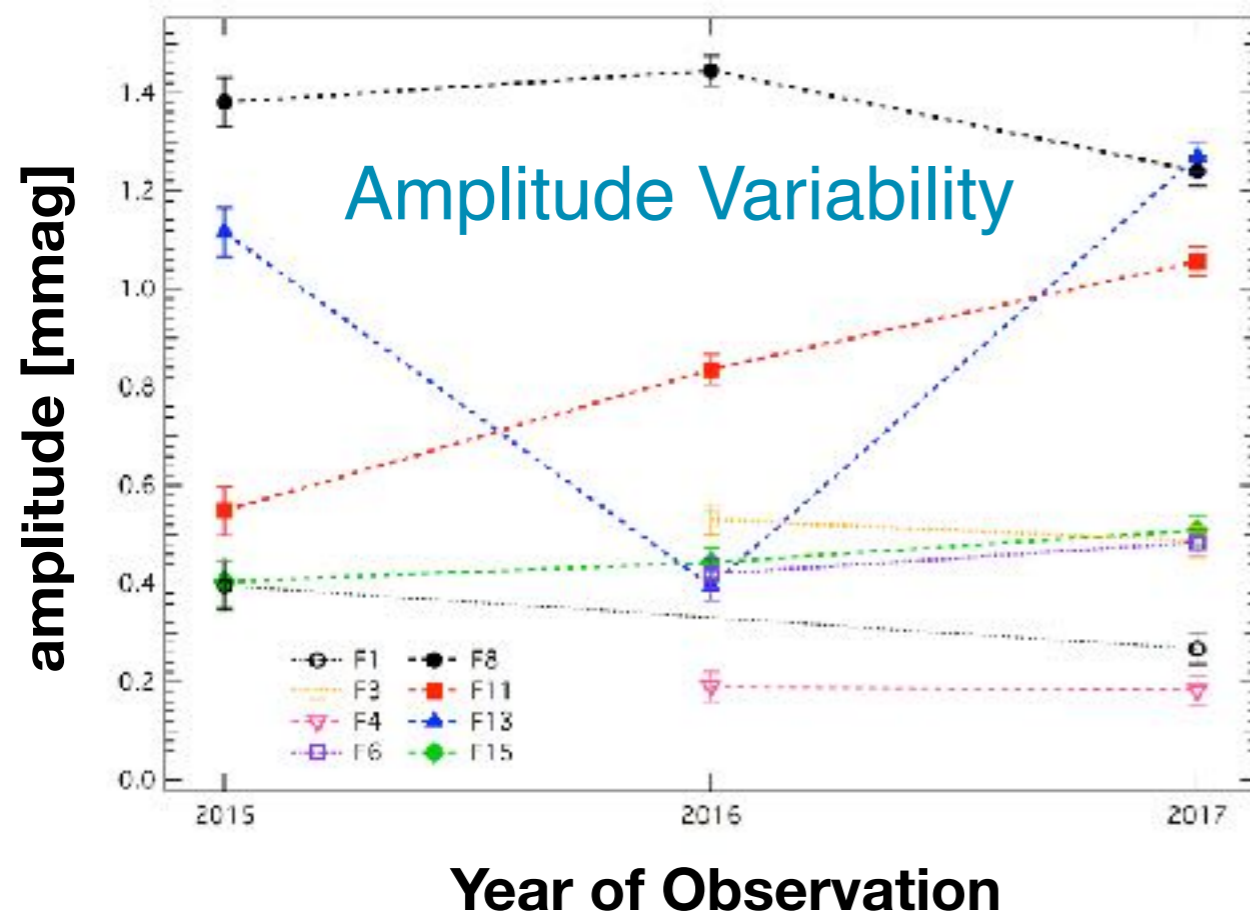
**International Observing Campaign:
Photometry & Spectroscopy**

HIGHLIGHT III: THE β PICTORIS SYSTEM

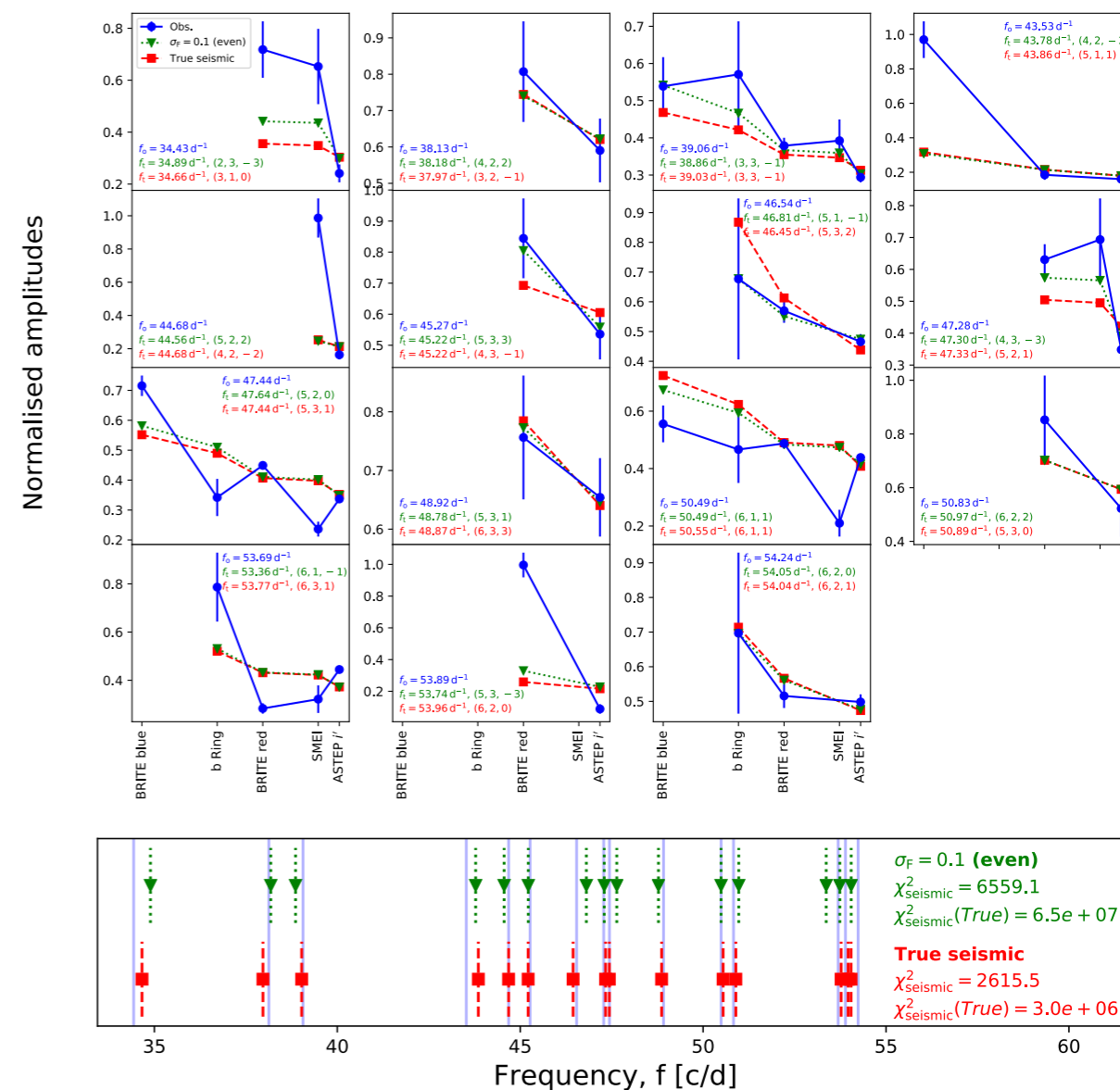


Pulsation frequencies
in multiple passbands

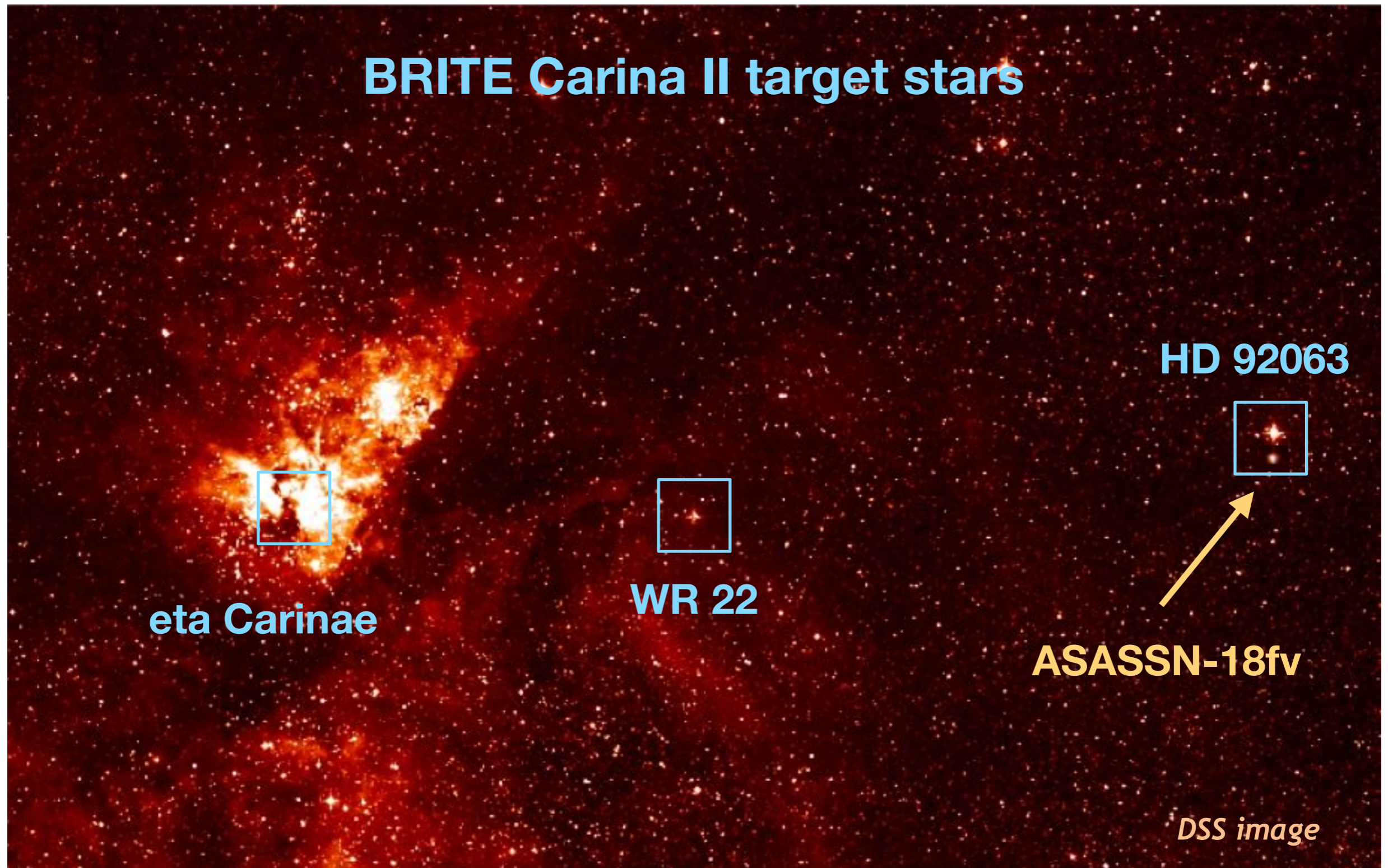
Asteroseismic Models



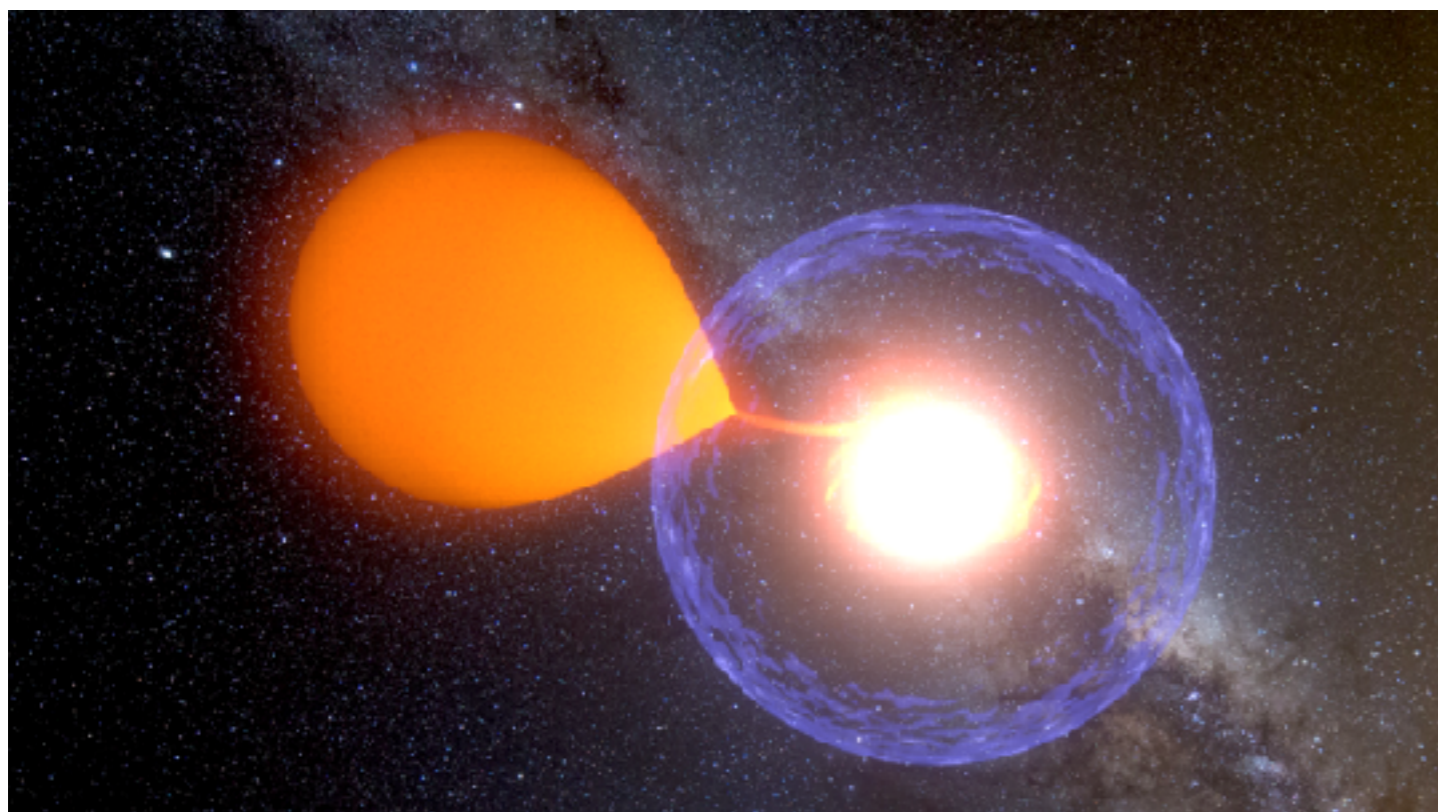
Zwintz et al. (2019, under review)



HIGHLIGHT IV: SURPRISE!



NOVAE



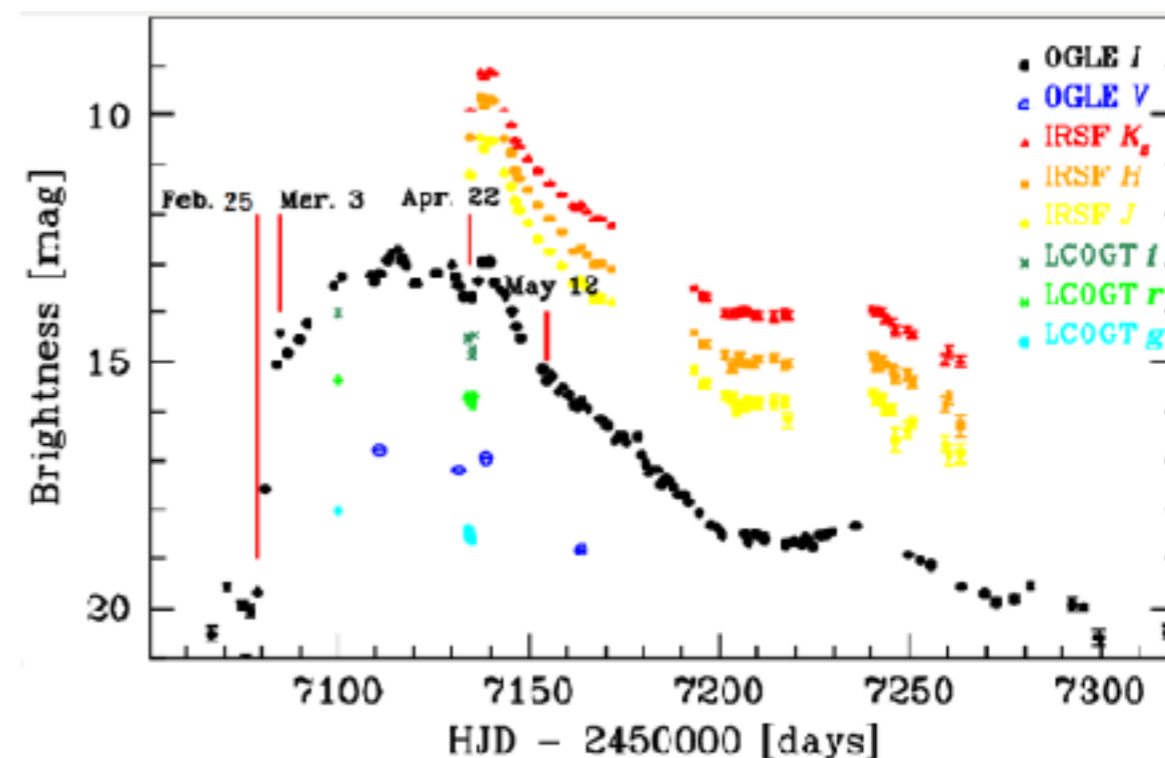
Nova Progenitors:

- ▶ pair of red dwarfs in the process of merging
- ▶ white dwarf and another star

Example:

Nova V5852 Sgr

(Aydi et al MNRAS, 461, 1529, 2016)



HIGHLIGHT IV: SURPRISE!

HD 92063

- ▶ Red Giant
- ▶ K1 III
- ▶ $V = 5.08$ mag

2018-03-01



2018-04-14

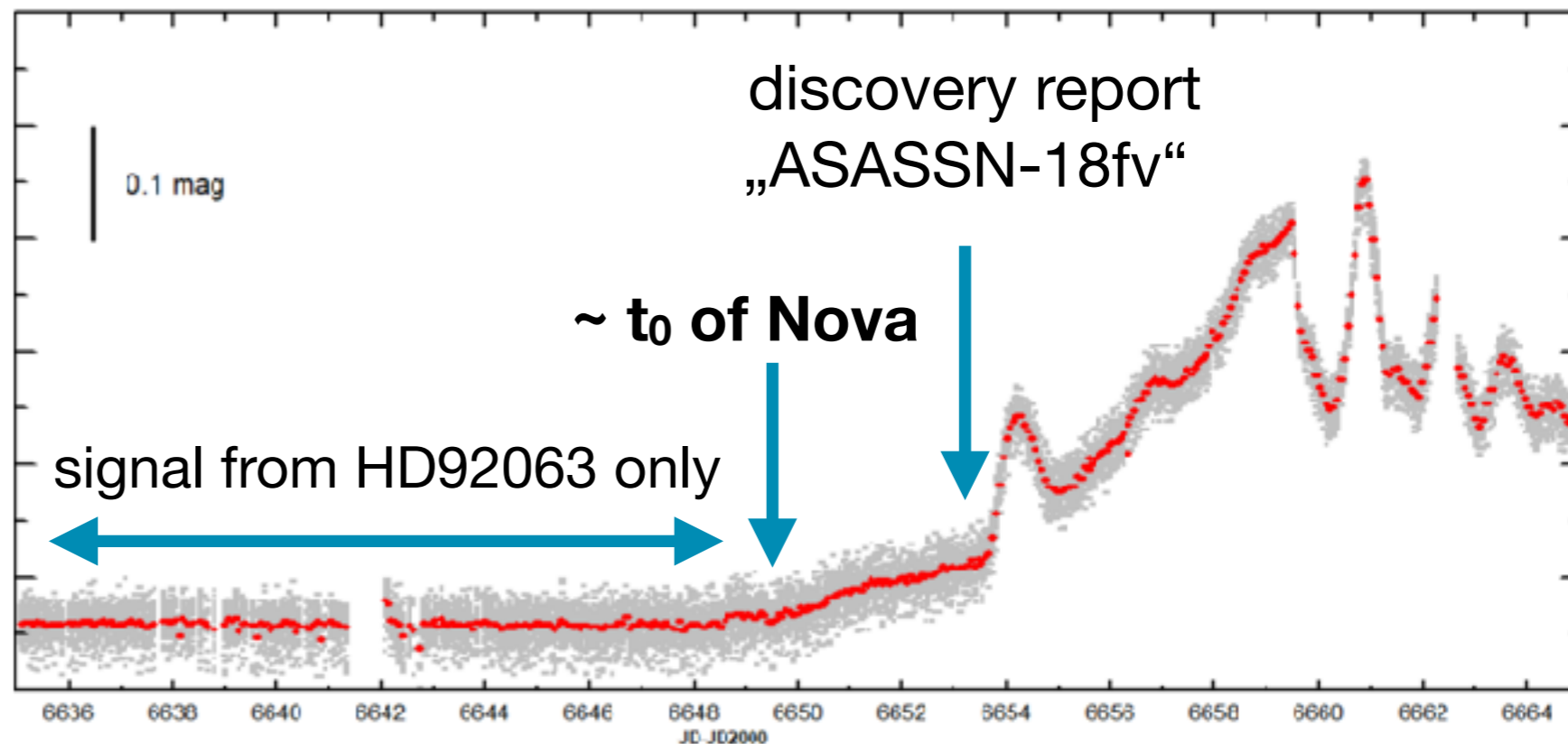


FWHM 8 pixel,
27"/pixel,
4 sec exposures,
550 – 700 nm

BRITE – Toronto (BTr) Satellite

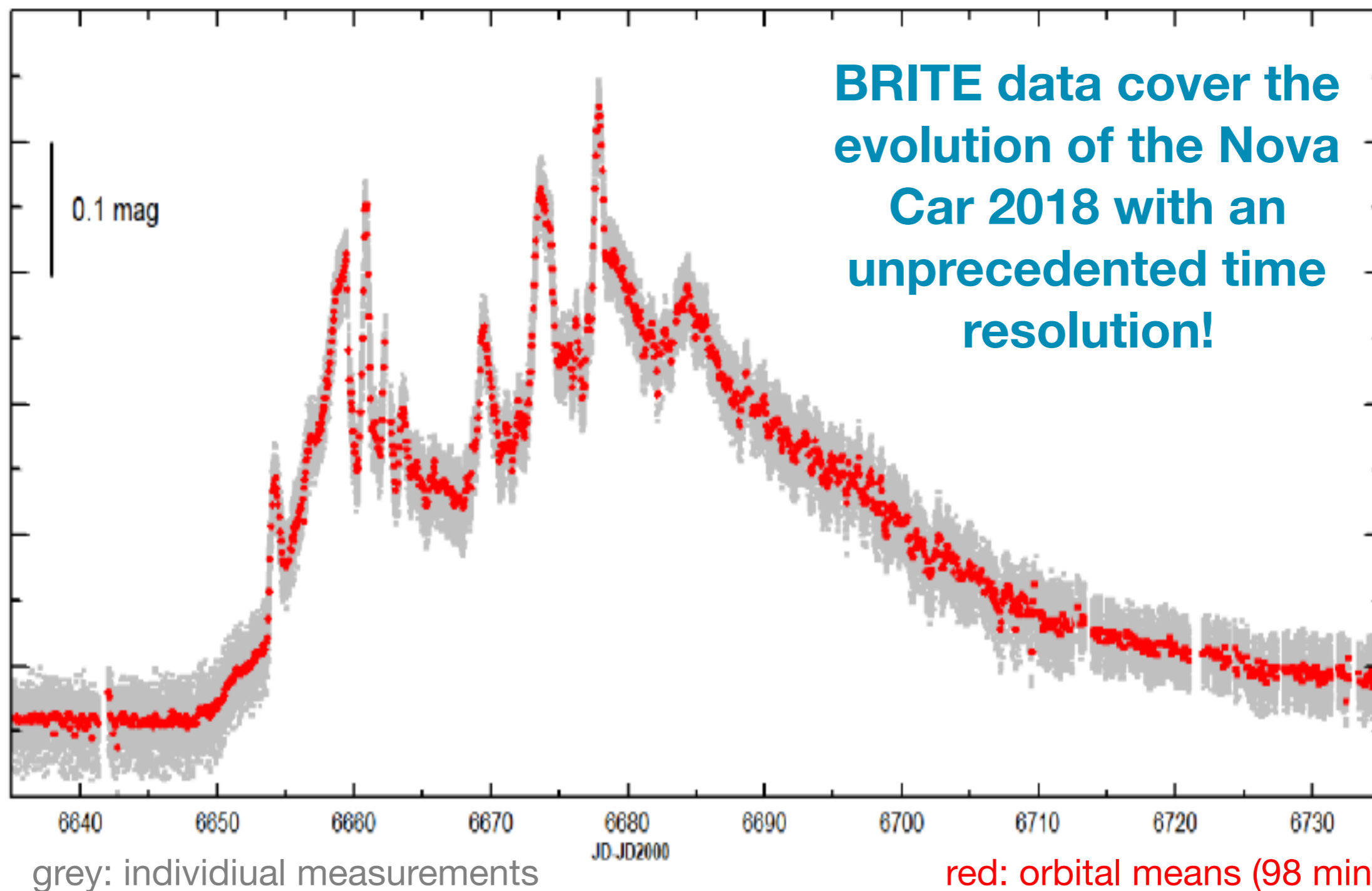
grey: individual measurements

red: orbital means (98 min)



HIGHLIGHT IV: SURPRISE!

Aydi et al. (2019, in prep.)



BRITE OPPORTUNITIES

◆ Observing Proposals: Submission any time

- Contact: konstanze.zwintz@uibk.ac.at

◆ BRITE Photometry Wiki:

<http://brite.craiq-astro.ca/>

- Observed, ongoing, future fields

- List of publications

◆ 10 future fields planned until 2020

◆ Webpage:

<http://www.brite-constellation.at>

Facebook:

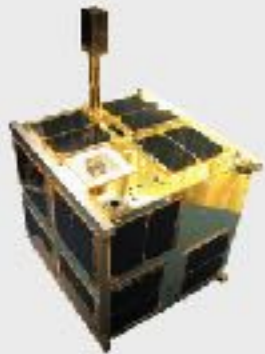
<http://www.facebook.com/briteconstellation>

The screenshot shows the BRITE Photometry Wiki interface. It includes a search bar, navigation links, and a main content area with a table of observation fields. The table has columns for Field ID, Ser. ID, Start Date, End Date, Duration, Stars, WCC, and Status.

Field ID	Ser. ID	Start Date	End Date	Duration ⁽¹⁾	Stars	WCC ⁽²⁾	Status
01-Cri-2012	UBr	2012-11-07	2012-05-17	130	15		released
	RAJ	2012-11-07	2012-05-17	130	15	5	released
02-Cen-2014	UBr	2014-03-23	2014-05-19	140	22		released
	UBr	2014-03-25	2014-05-17	140	20	5	released
03-Egr-2014	UBr	2014-04-23	2014-05-28	30	10		released
	UBr	2014-04-23	2014-05-28	30	10	0	released
04-Cya-2014	UBr	2014-05-12	2014-11-24	168	36		released
	UBr	2014-05-12	2014-07-01	10	24	5	released
05-Per-2014	UBr	2014-09-04	2015-02-18	168	37		released
	UBr	2014-09-04	2015-02-18	168	37	5/7	released
06-Per-2014	UBr	2014-09-04	2015-02-18	168	37		released
	UBr	2014-09-04	2015-02-18	168	37	5	released
07-Orn-2015	UBr	2015-09-25	2015-09-16	171	25		released
	UBr	2015-09-25	2015-09-16	171	25	5	released
08-Ver-2015	UBr	2015-09-25	2015-09-16	171	25		released
	UBr	2015-09-25	2015-09-16	171	25	5	released
09-Cor-2015	UBr	2015-09-25	2015-09-29	107	26		released
	UBr	2015-09-25	2015-09-29	107	26	5	released

BRITE-CONSTELLATION IN NUMBERS

6 YEARS IN SPACE



BRITE-Austria
UniBRITE
BRITE-Lem
BRITE-Heweliusz
BRITE-Toronto

133 658 ORBITS



42 CAMPAIGNS



**625 STARS
OBSERVED**

**NO FUEL
USED**



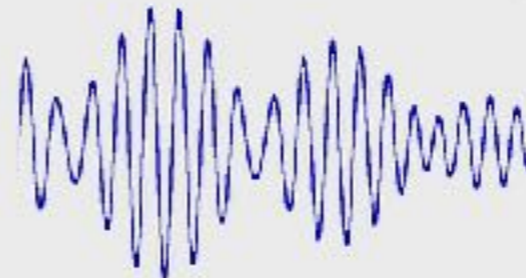
**TRAVELLED 6.1
BILLION KILOMETERS**
About the distance Earth - Pluto



**171 PUBLISHED
SCIENTIFIC
PUBLICATIONS**



**63 GB
SCIENCE DATA**



**4.3 MILLION
DATA POINTS**

LONGEST TIME BASE: 5.3 YEARS

2013



2019