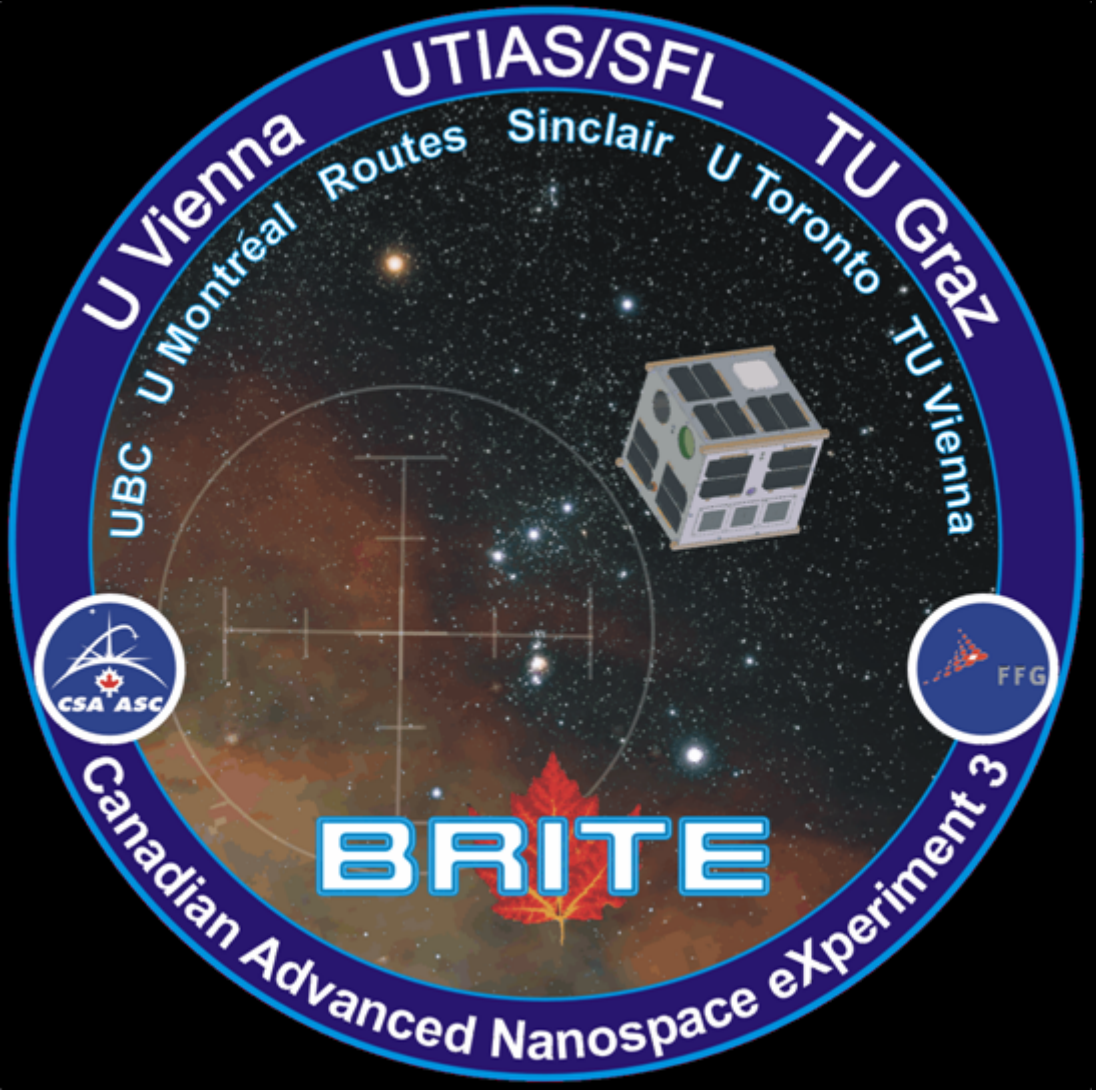
BRIght Target Explorer
Constellation of 4 nanosatellites

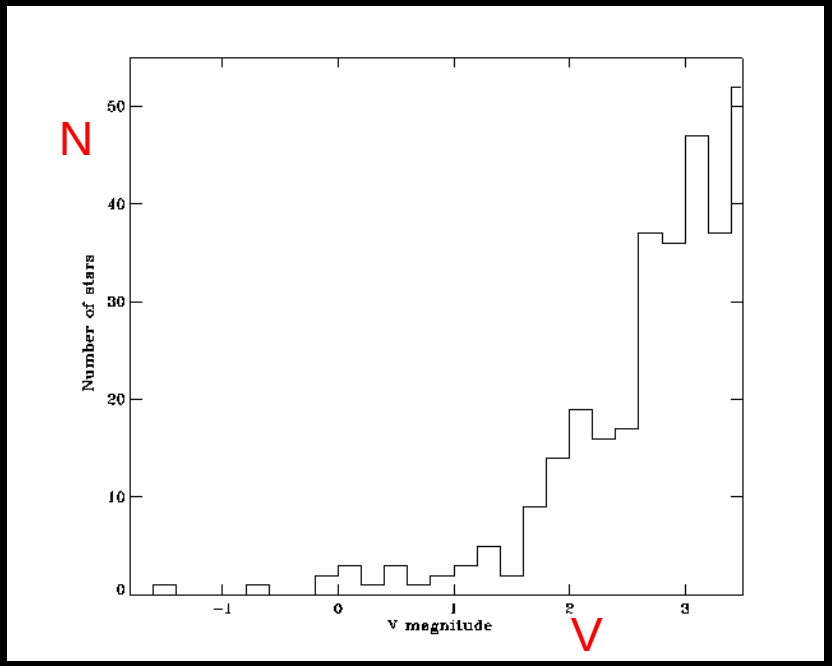


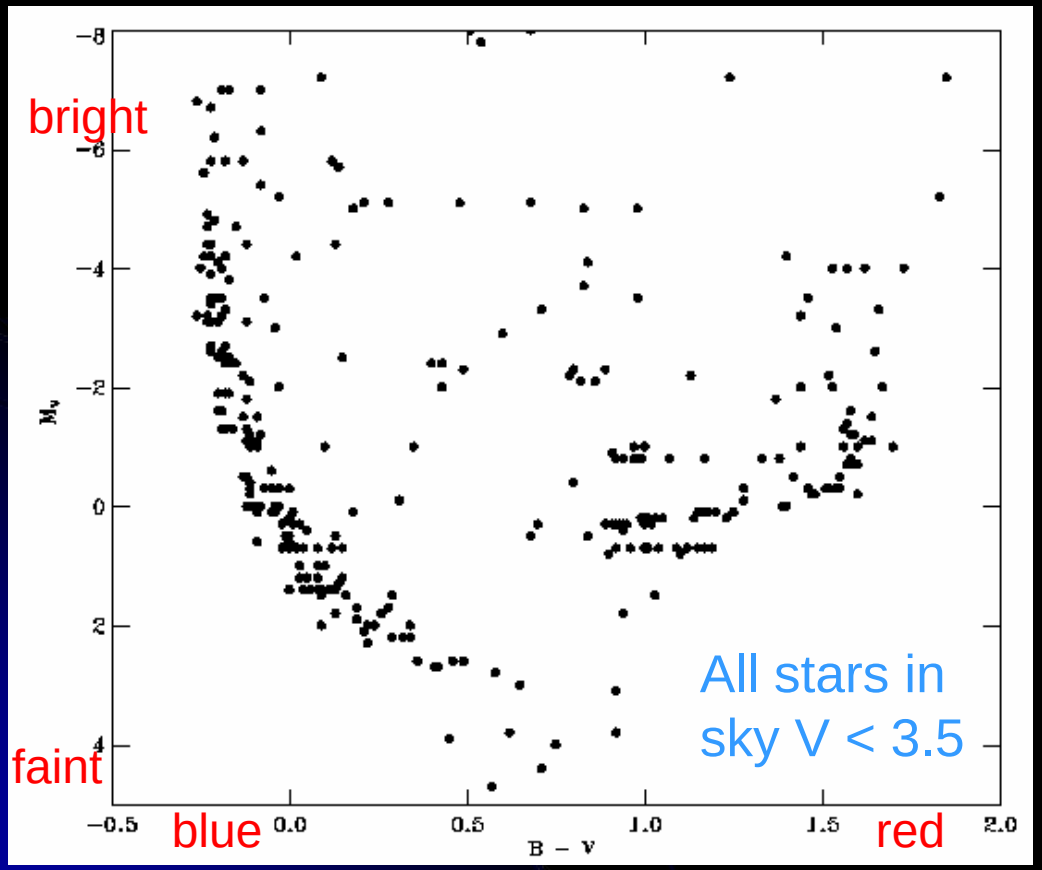
Another all-Canadian first

Chain of arguments leading up to BRITE

- Stars are the ecological motors of the Universe
- Full understanding requires probing their interiors
- → Asteroseismology! (neutrinos not yet practical)
- → Long-term, uninterrupted, high-precision photometry
- Best from space (no atmosphere, continuous viewing)
- Telescopes can be very small (bright stars)
- Need for small satellites
- Niche for Canada (modest budget, develop industry & HQP)
- Until now, most space telescopes large (pointing stability)
- Enter unique ventures with MOST and now BRITE

As it turns out, the apparently brightest stars in the sky → also the intrinsically brightest → good tracers of the ecology of the Universe

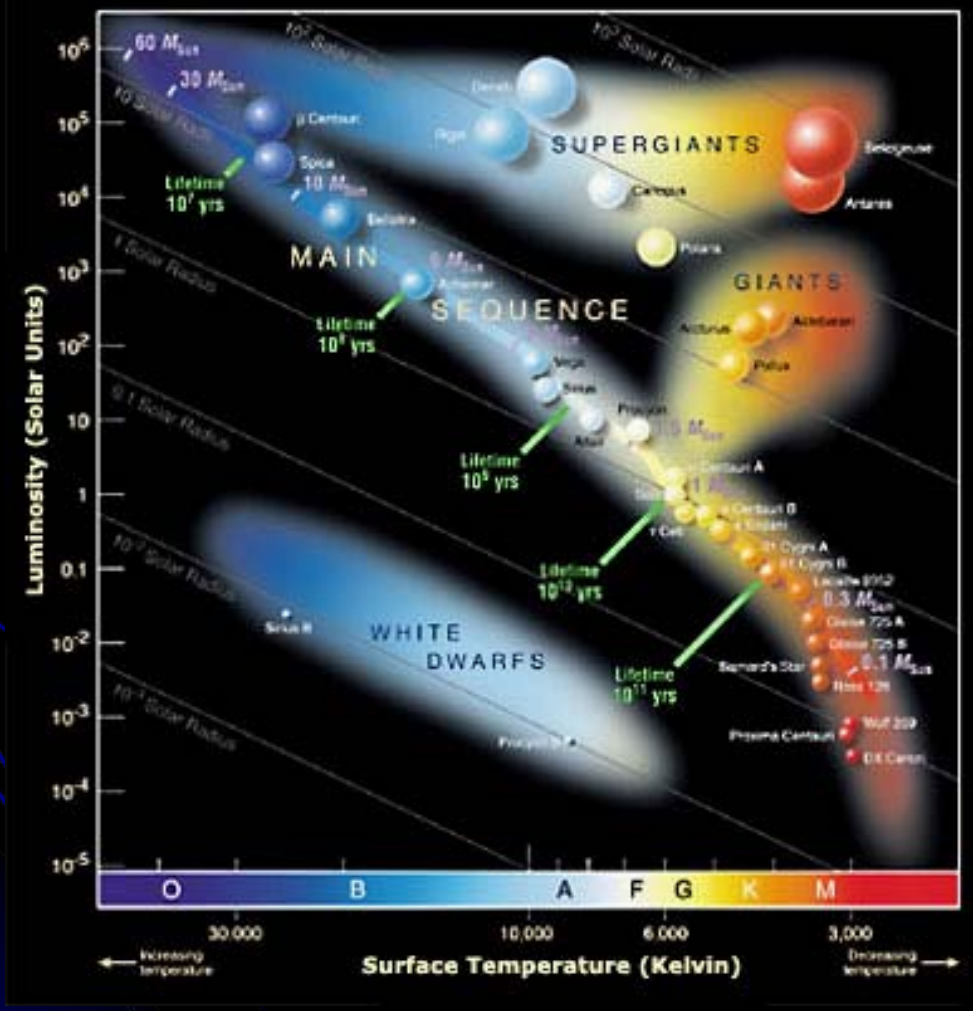




Main drivers of the ecology of the Universe:

→ LUMINOUS STARS

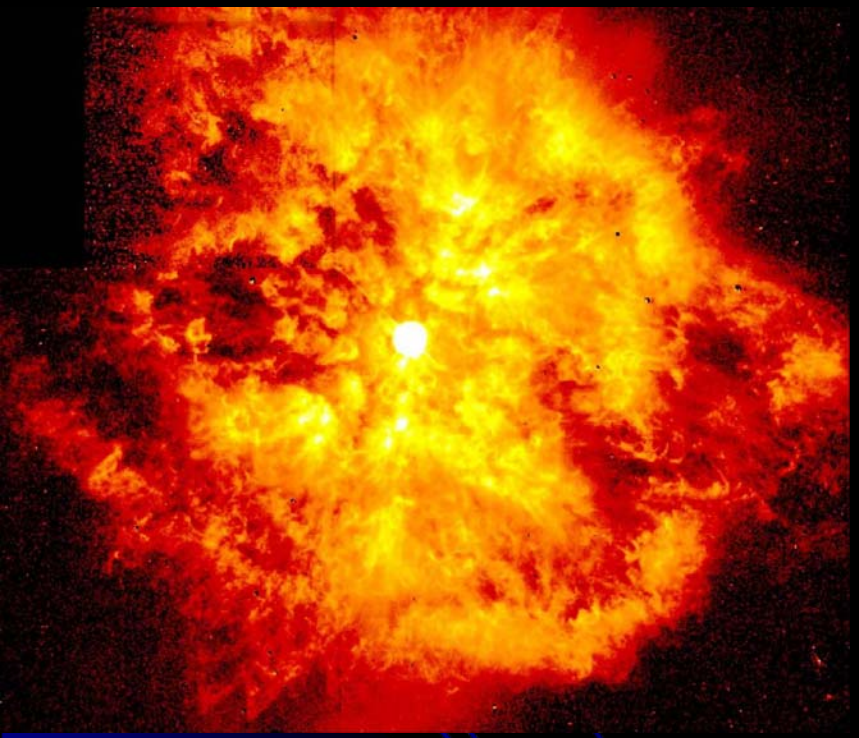
HOT



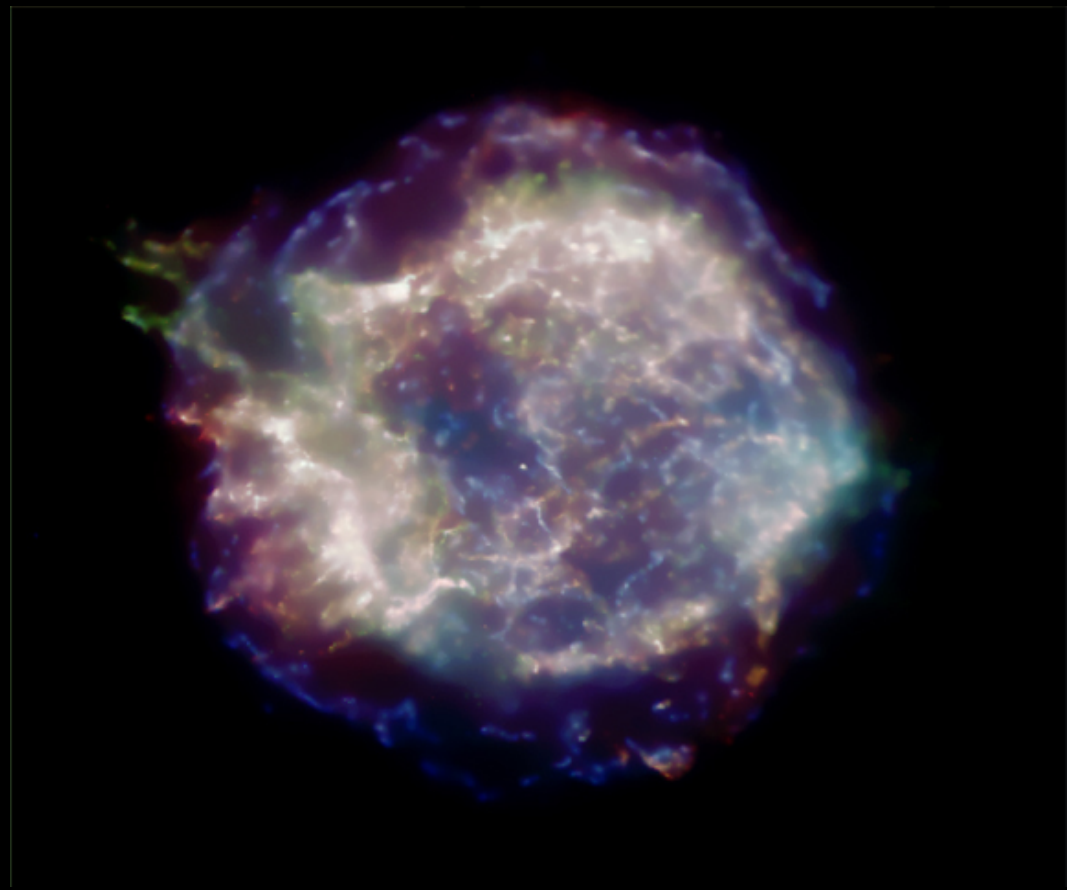
COOL

(a) HOT: mostly OB stars of 8 – 100 $M_\odot$

→ winds & supernovae



M1-67 + WR124 (WN8) HST/Hα

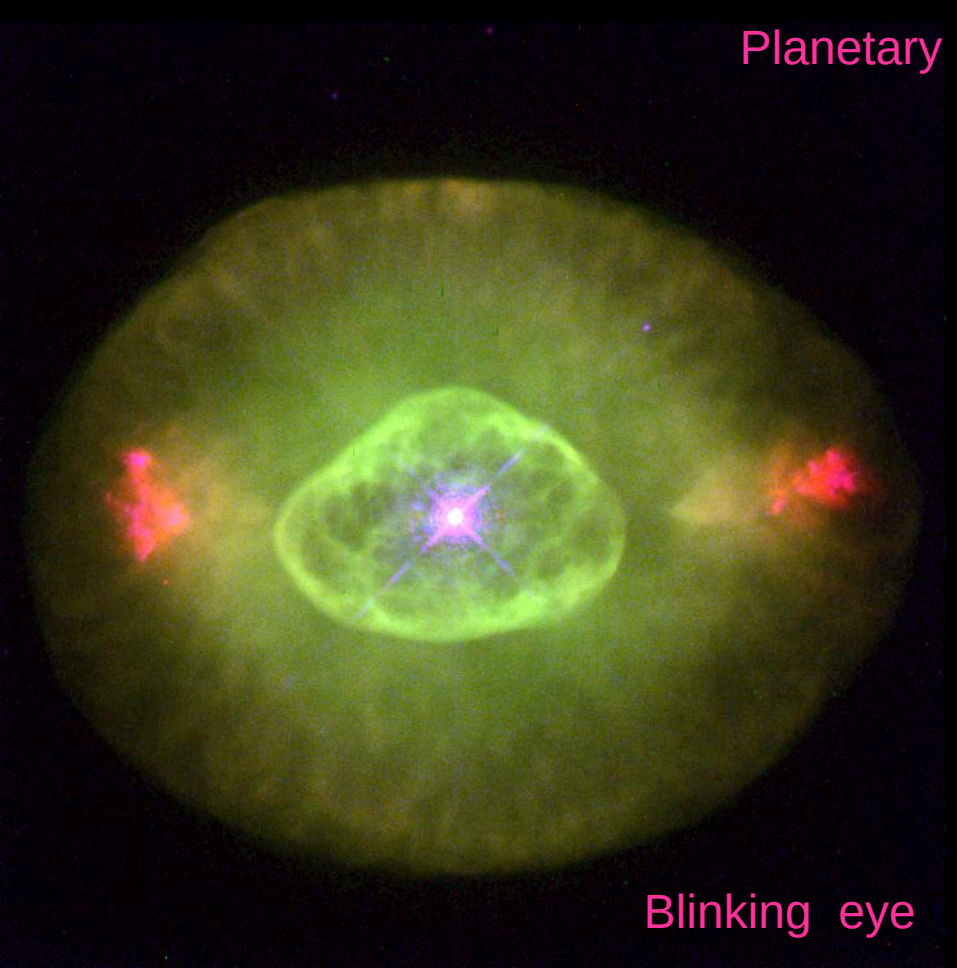


SNR Cas A Chandra/X-rays

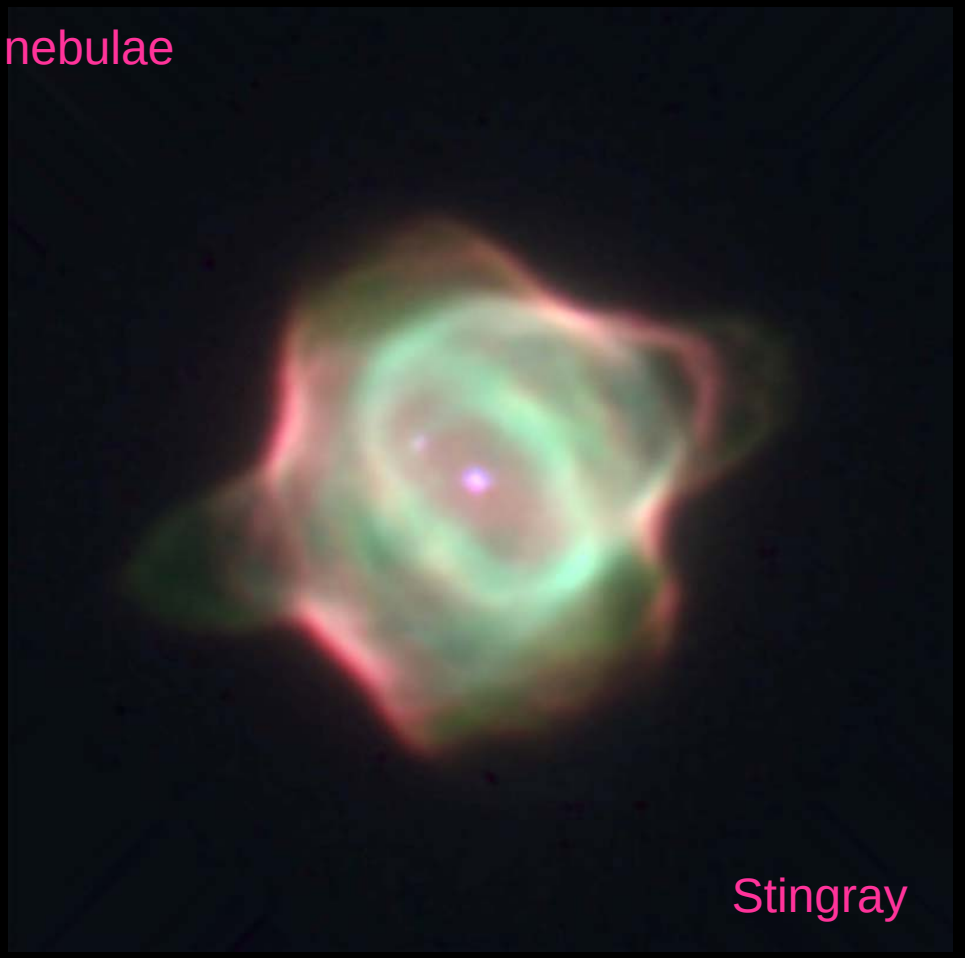
(b) COOL: mostly highly evolved stars (RG, AGB) of $M_i = 1 – 8\ M_\odot$

→ winds at end

Planetary nebulae



Blinking eye



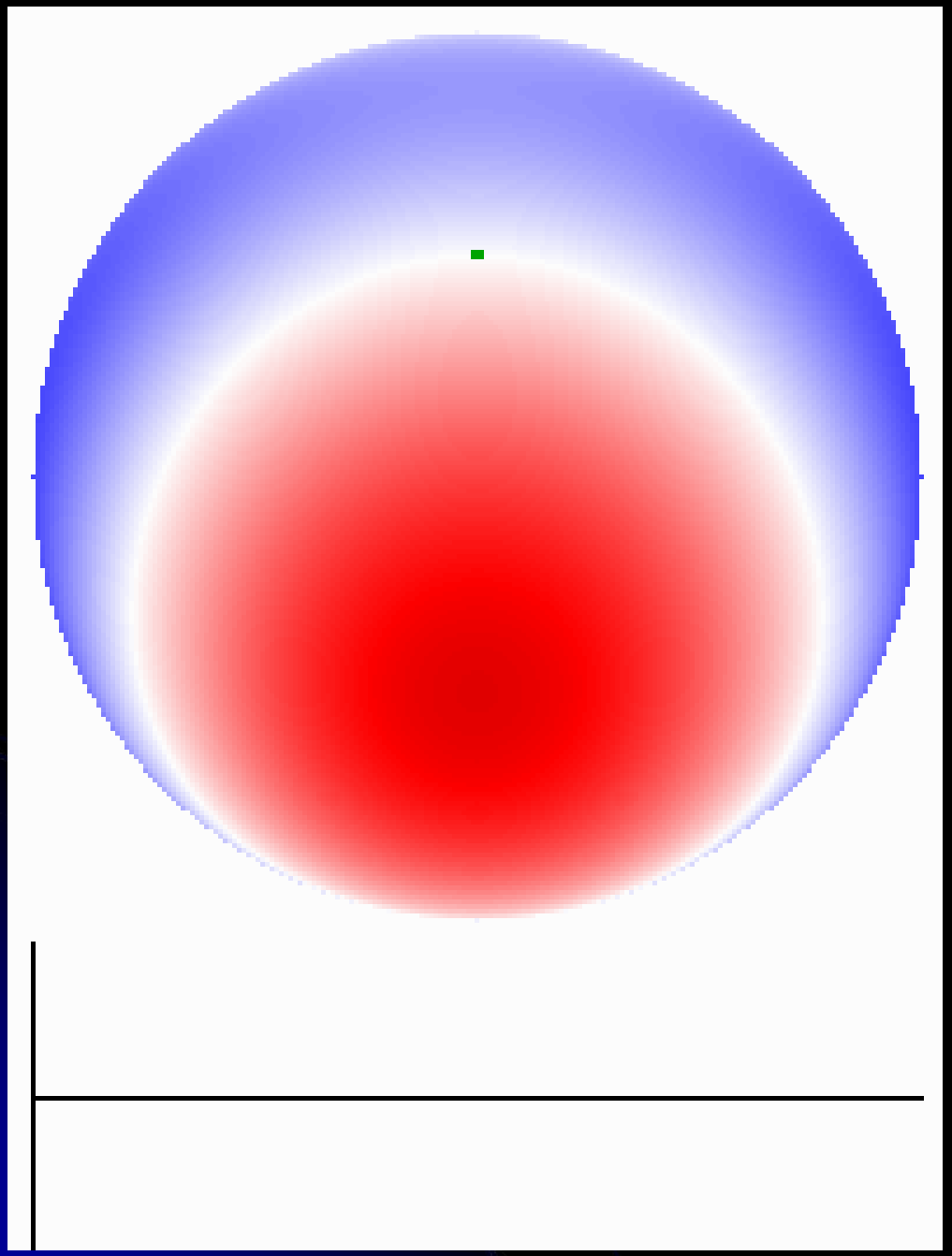
Stingray

… BUT: properties of luminous stars still poorly understood → large uncertainties in stellar life cycle

- Massive stars: size of convective cores, influence of rotation

- Evolved moderate-mass stars: almost wholly convective

The primary goal of BRITE-Constellation is to constrain the basic properties of intrinsically luminous stars – i.e. stars that most affect the ecology of the Universe – by measuring their oscillations on hour to month timescales, based on dual-broadband, ultra-high precision photometric time-series from space.

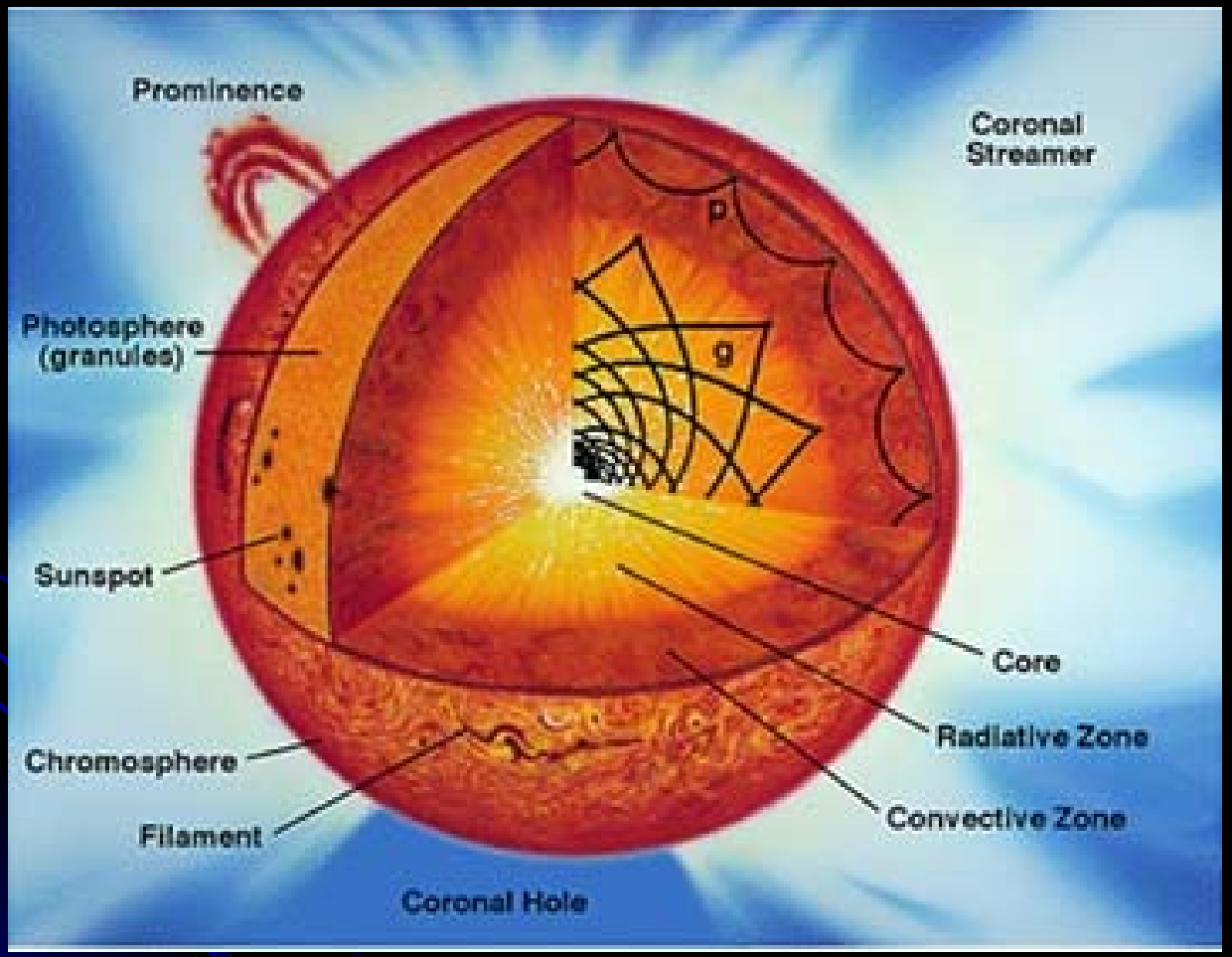


What we expect to see

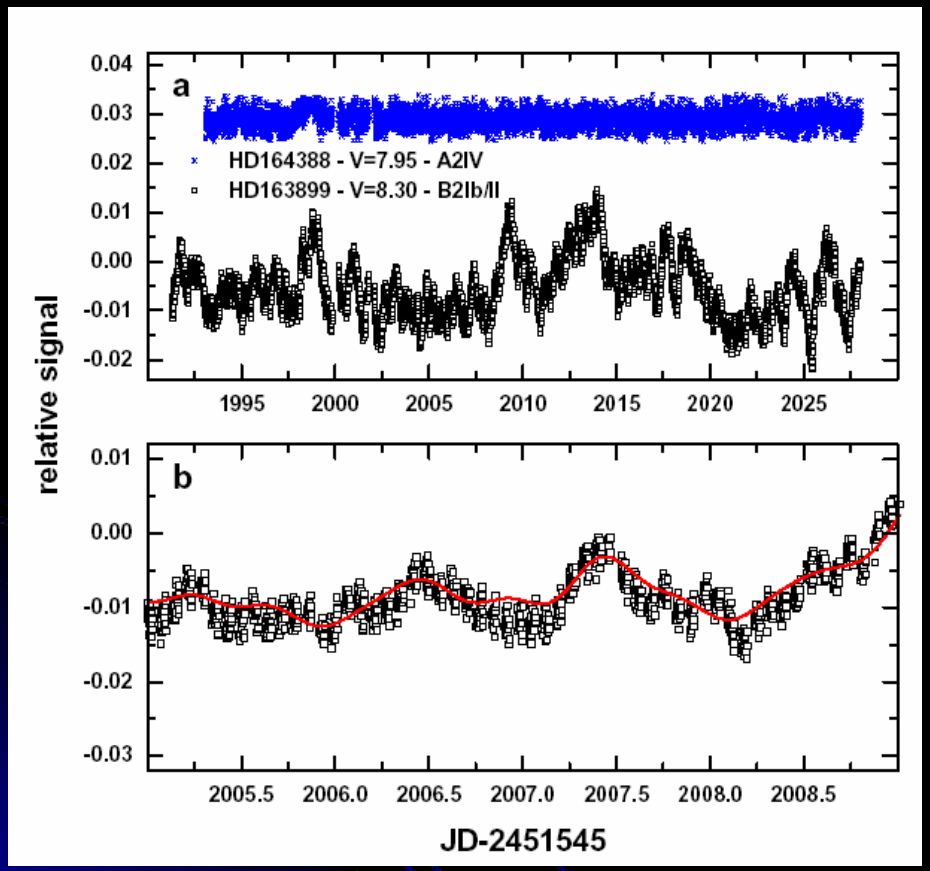
Example of total-light light-curve from simulated low-order, non-radial pulsations

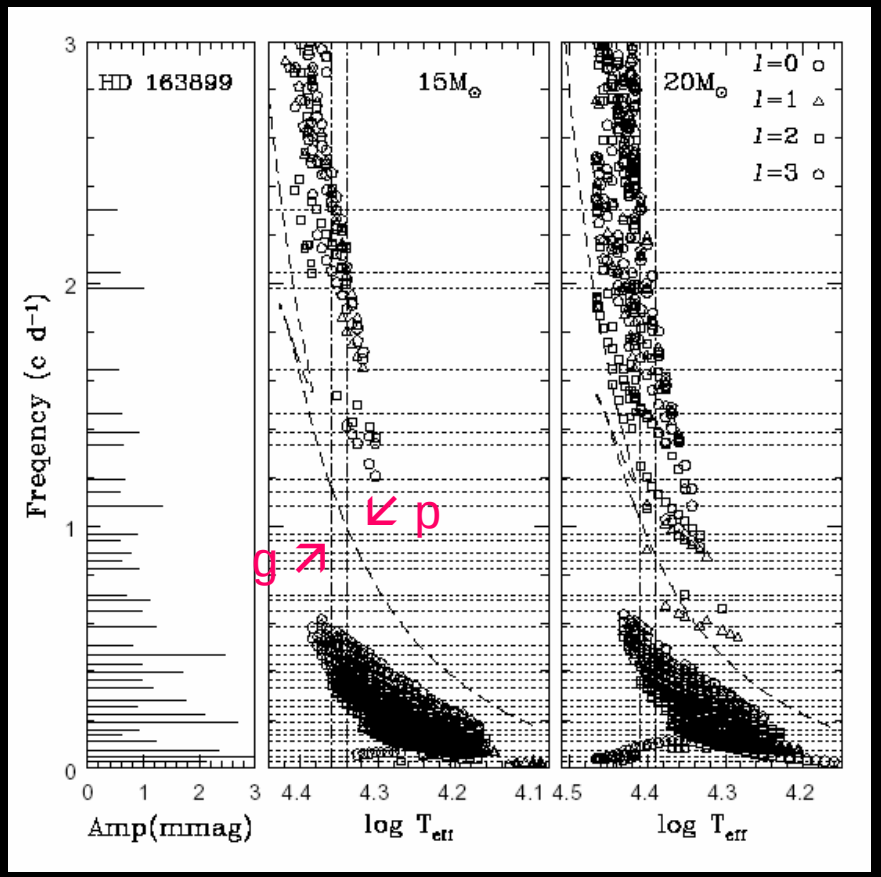
⇳ mmag

… and as seen inside the star



e.g. from MOST: HD163899, B2Ib/II



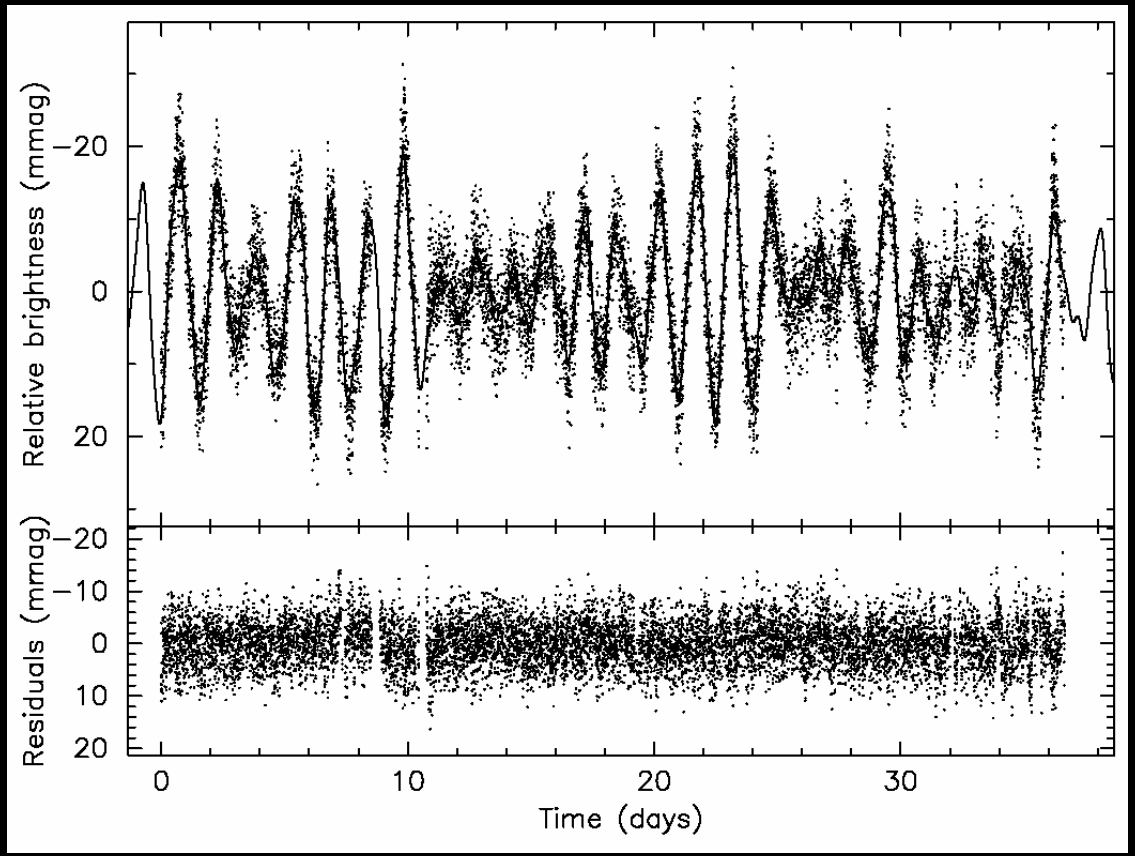


~35 frequencies, p- & g-modes → first time in a BSG!

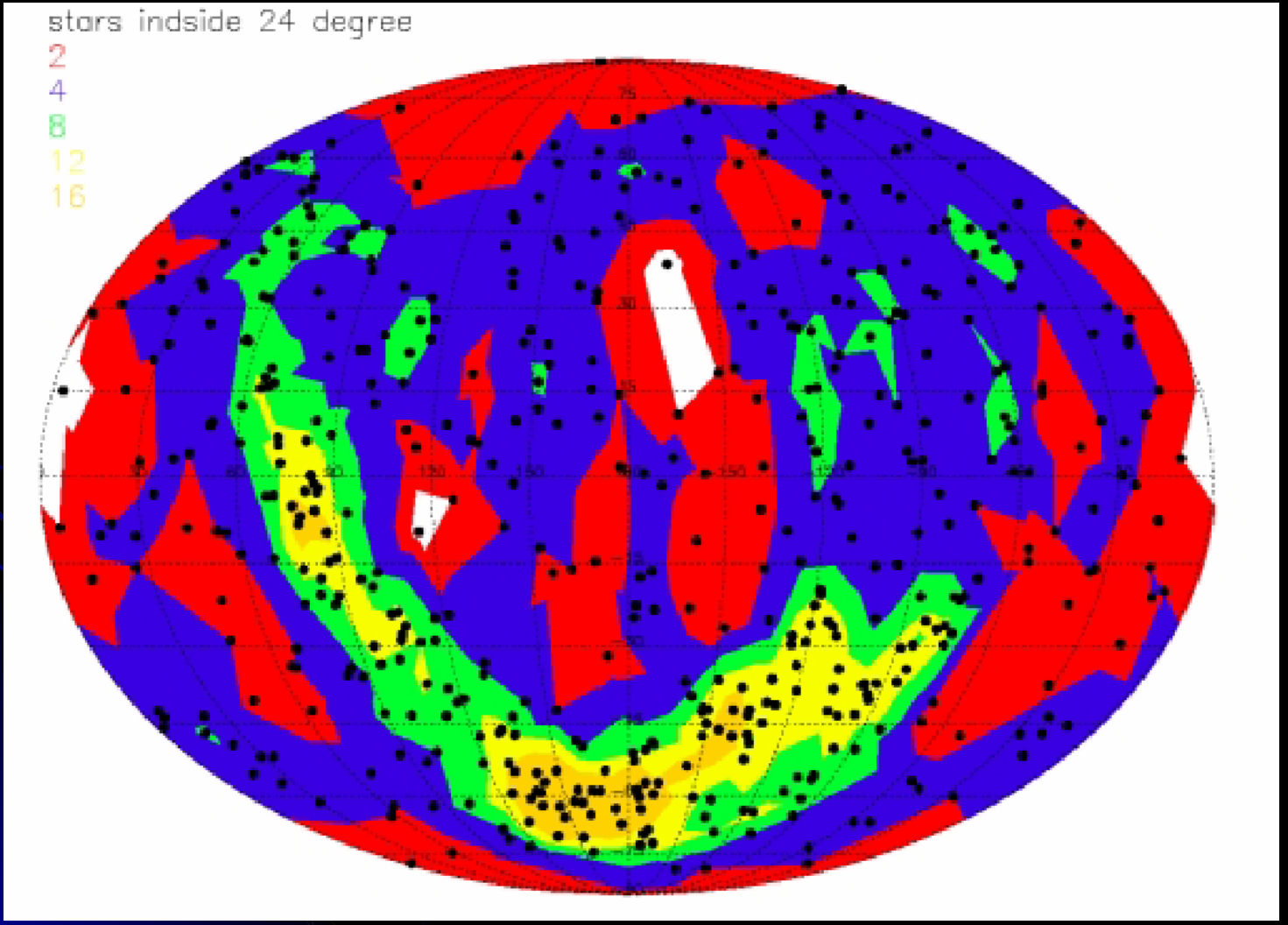
Another MOST result: HD163830, B5II/III

A new SPB with largest no. (20) of detected g-mode frequencies

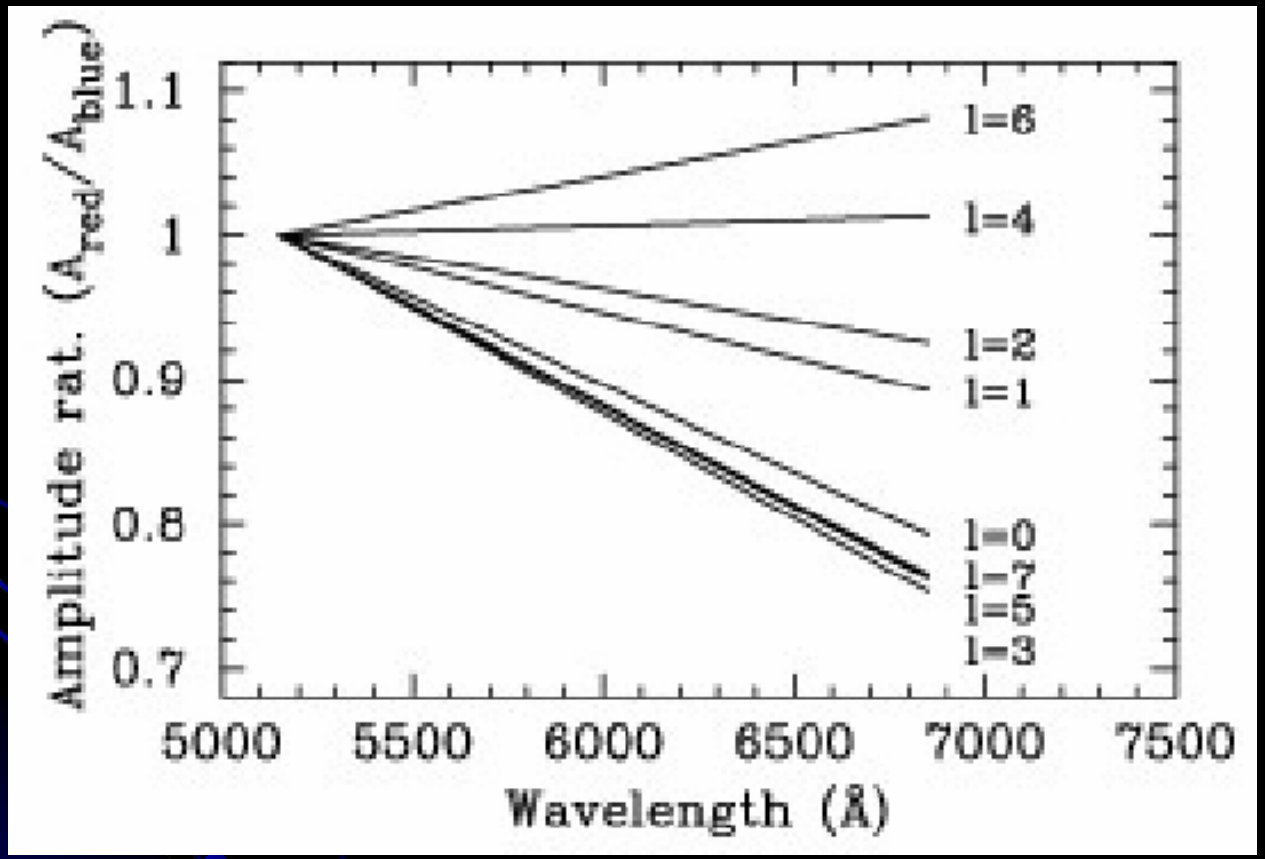
Model: 4.5 $M_{\odot}$



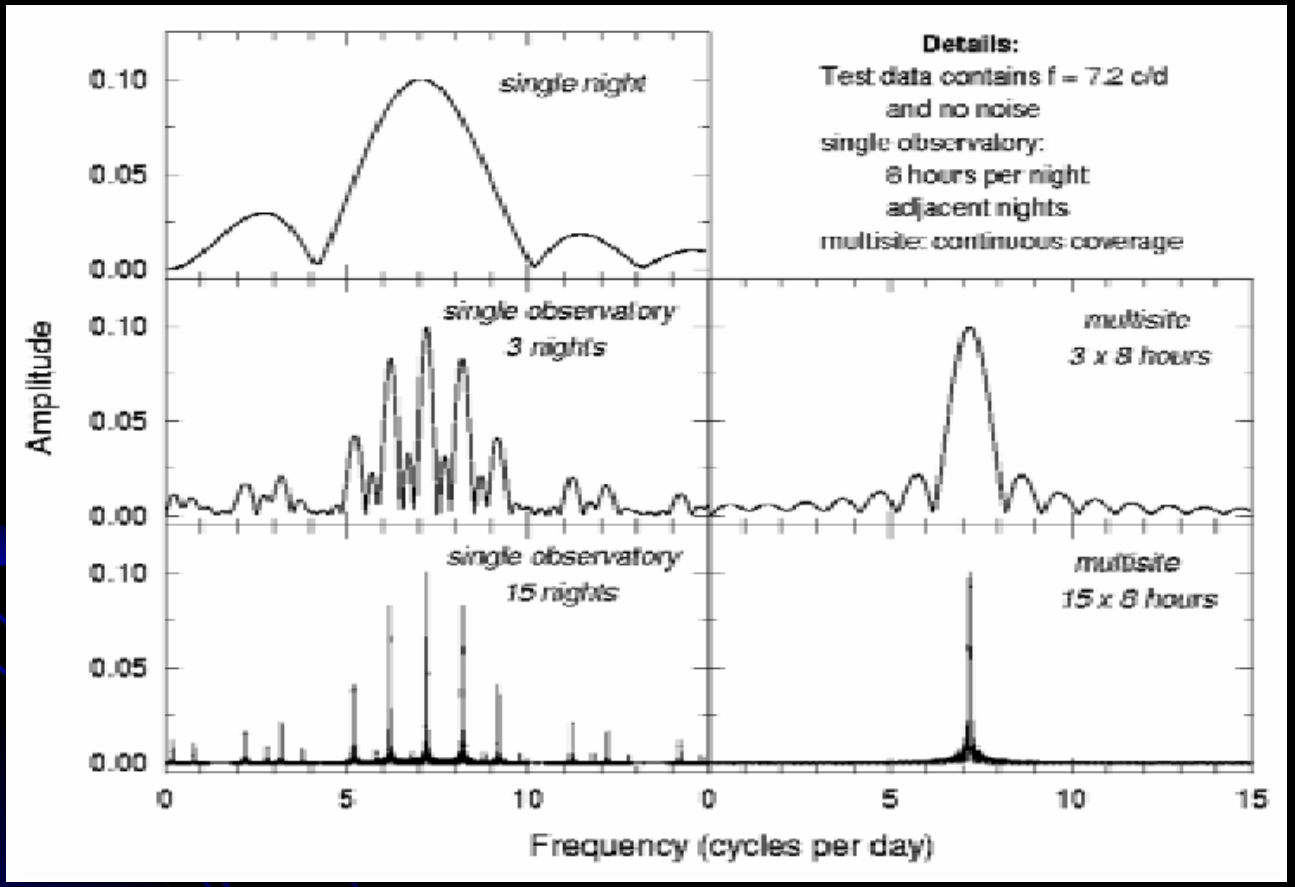
BRITE field of ~25 degrees across → typically observe 4 stars of V < 3.5 simultaneously:



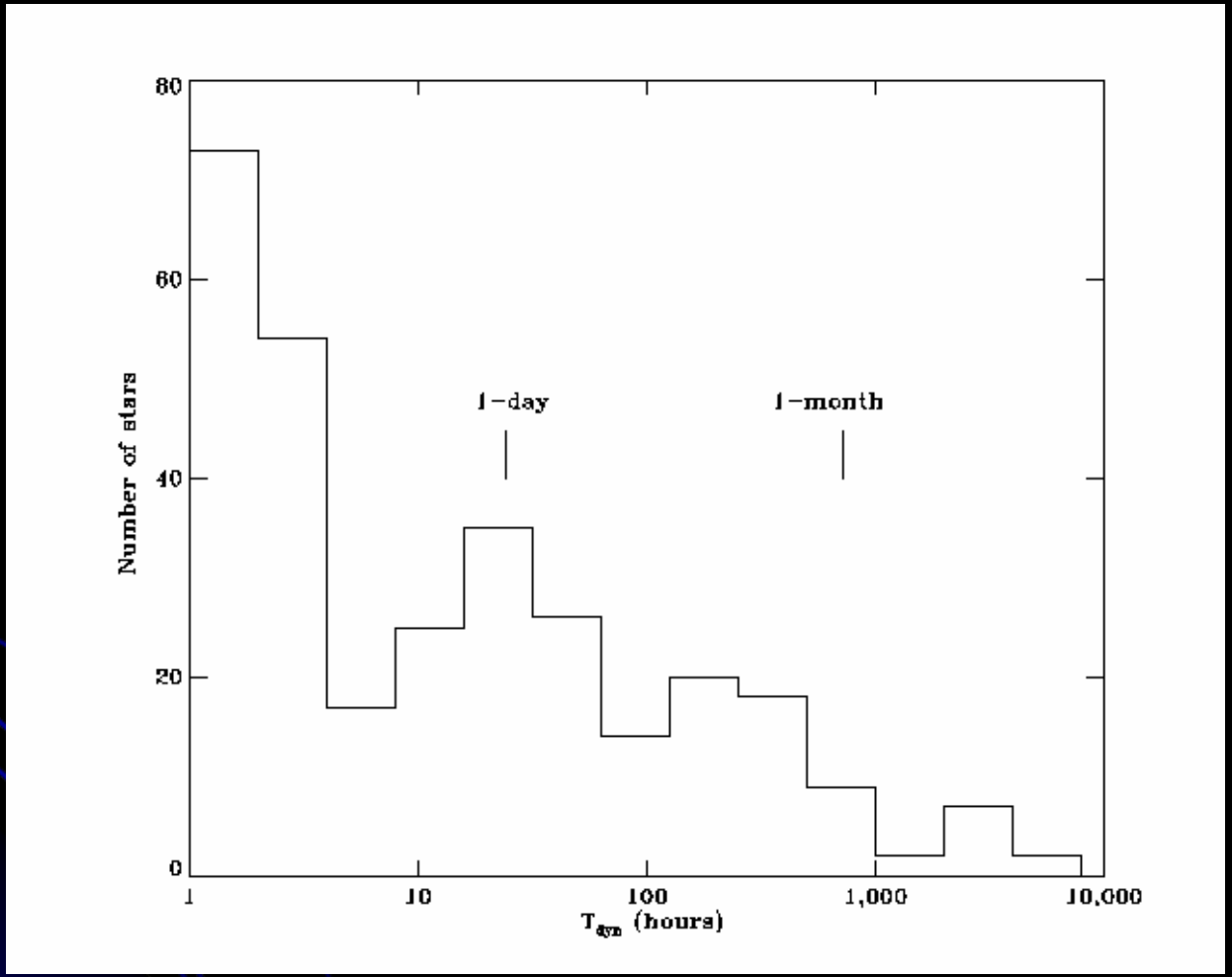
Colour information → temperature variations
→ better constrain structure



Fill in time gaps of most likely equatorial orbit



Pulsation timescale (~ $1/\sqrt{G\rho}$) longer for luminous stars ($\rho\downarrow$)



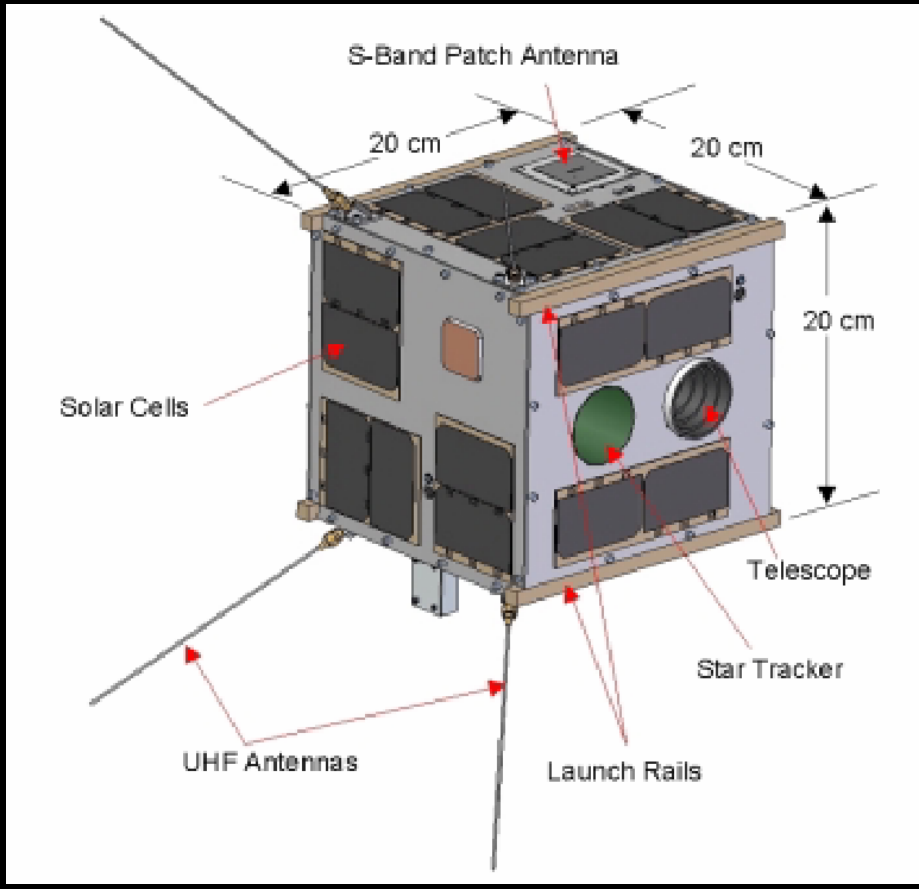
➔ Need several pairs (2 filters) of 30 mm telescopes in simultaneaous orbit. We settle for minimum 2 pairs → BRITE CONSTELLATION

… in summary for a single BRITE telescope:

Scientific requirement	Minimum requirements
Apparent magnitude limit	+3.5
Positional constraints	None, all parts of the sky
Field of view	>25 degrees diameter
Differential photometry error per single observation	<0.1%
Error of amplitude spectrum for >month	$<2\times10^{-5}$ (or 20 ppm)
Cadence (repeat of the same field)	<100 minutes
Duration of the mission	> 2 years

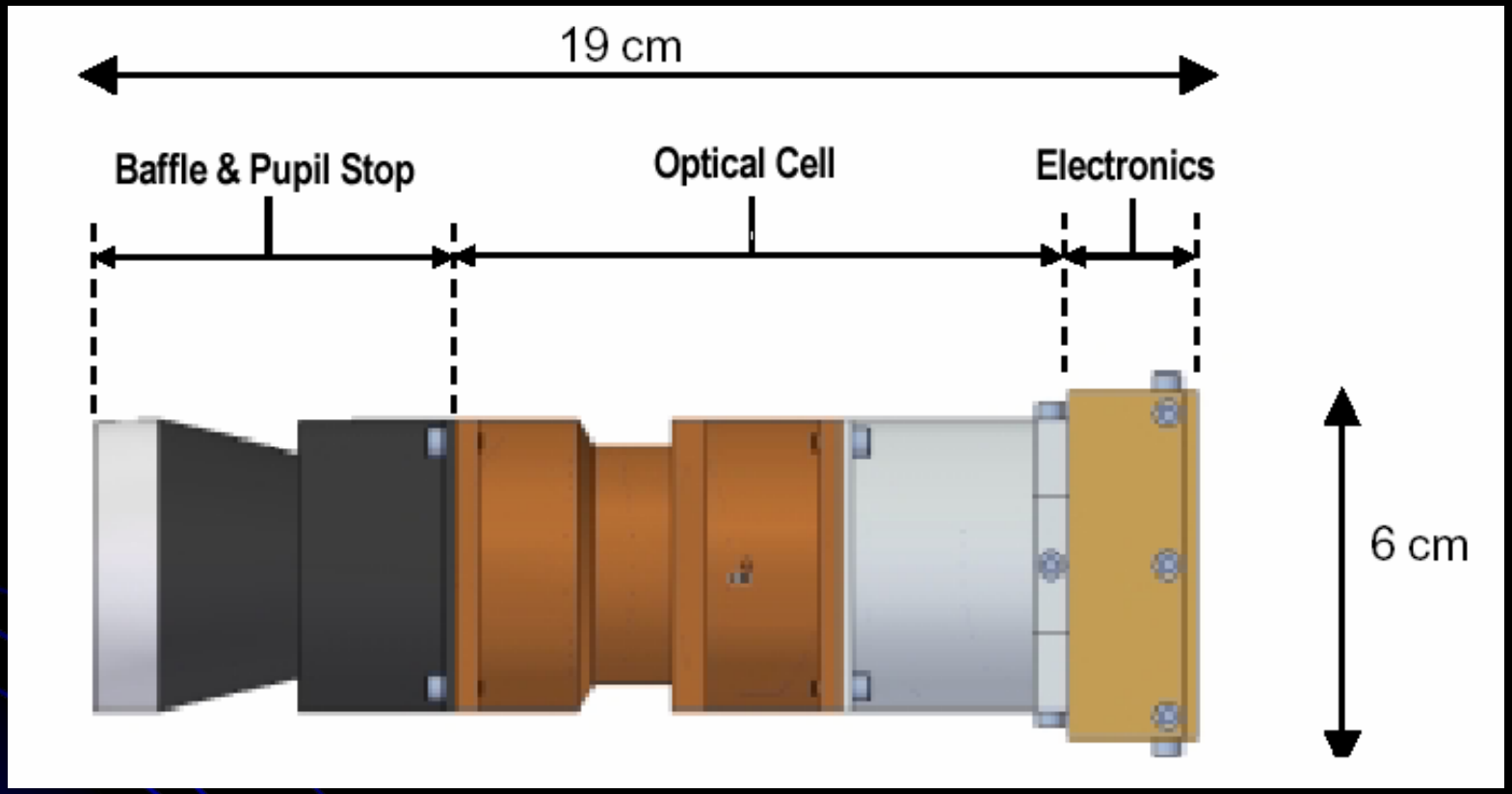
BRITE satellite bus & attitude control

Satellite Specification	*Value*
Volume	20×20×20cm
Mass	5.0kg
Attitude Determination	10 arcseconds
Attitude Control Accuracy	Better than 1.0°
Attitude Control Stability	1 arcminute RMS
Power	5.4W to 10W
Bus Voltage	4.0V (nominal)
Battery Capacity	5.3Ah
Data Downlink	Up to 256Kbps
Payload Data Storage	Up to 256MB



N.B.: key elements: miniature reaction wheels + magnetorquer coils → unique development in Canada (UTIAS/SFL)

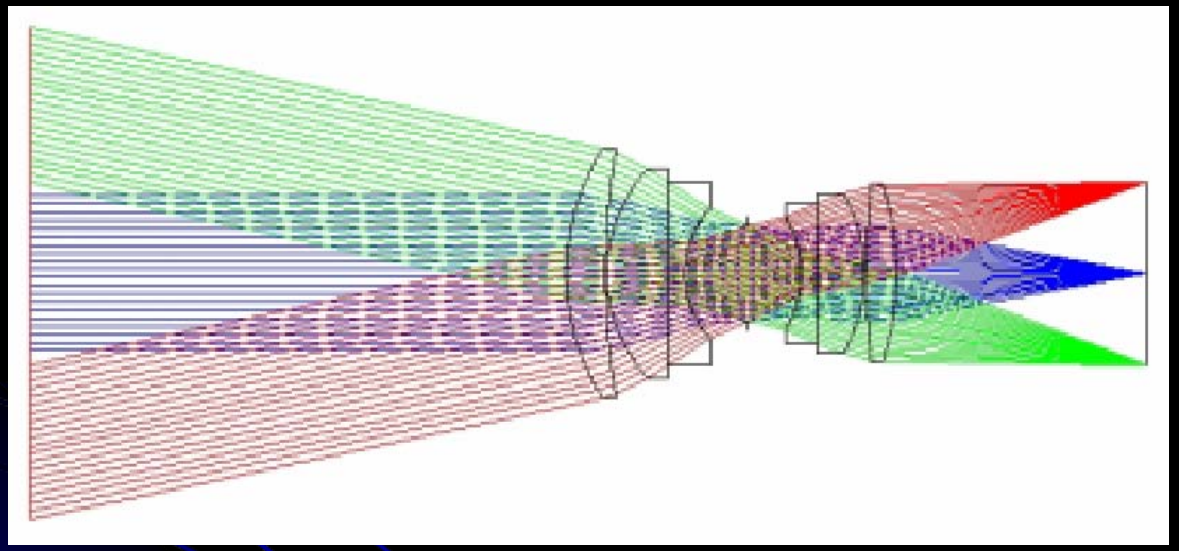
BRITE telescope & baffle:



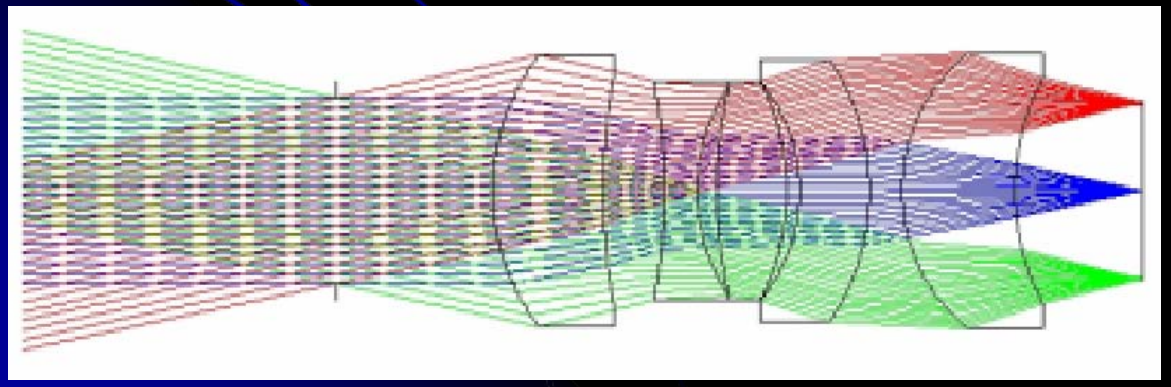
Detector: Kodak CCD

BRITE telescope optics

Non-sharp images → match several 24” (8 μm) pixels



Traditional double-Gauss design



External aperture-stop configuration (better: smaller baffle)

In summary….

CanX-3

BRIght Target Explorer (BRITE) Constellation

Son of MOST

- Space Astronomy (Canada, Austria, Poland)
- Similar to MOST science, but focused on the brightest stars in our Galaxy with longer periods of oscillation
- Structure of luminous stars, evolution of the universe, creation of heavy elements
- 6 kg, 20x20x20cm each
- “Nano” Star Tracker, Reaction Wheels give 1 arcminute pointing stability
- 3 cm aperture optical telescope
- First two of six nanosats: Launch in mid 2011 (ISRO, India)

BRITE Constellation

Benefits to Canada

- Forefront research in space
- International collaboration (Austria, Poland, +?)
- National collaboration
- Education opportunities (science & engineering)
- Impact on Canadian industry
- Potential for growth in future missions

BRITE Constellation

Luminous Stars as Cosmic Engines

BRITE Executive Science Team

Canada: A.F.J. Moffat, PI; J.M. Matthews, S.W. Mochnacki, S.M. Rucinski

Austria: W.W. Weiss, PI, M. Breger, O. Koudelka, R. Kuschnig;

Poland: A. Schwarzenberg-Cerny, PI, P. Orleanski, A. Pamyatnykh, A. Pigulski

+ 80 others world-wide

BRITE
Collaborators so far

… what about: