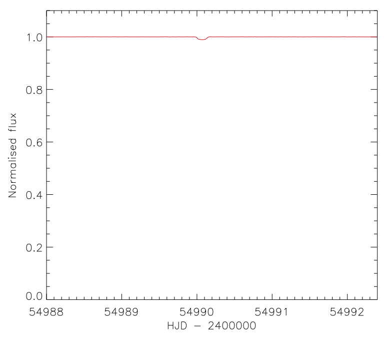
ECLIPSING BINARIES FROM PLATO

KEELE UNIVERSITY

John Southworth (STFC Advanced Fellow)

Transiting planet searches

- If you look for planets, you will find eclipsing binaries
- Eclipsing binaries appear to be much more common than eclipsing planets



Transiting planet searches

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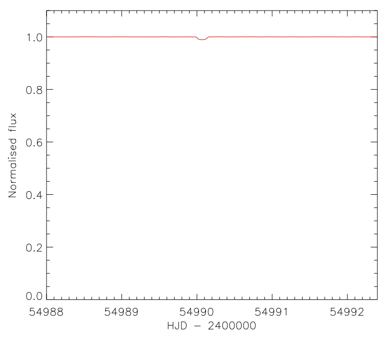
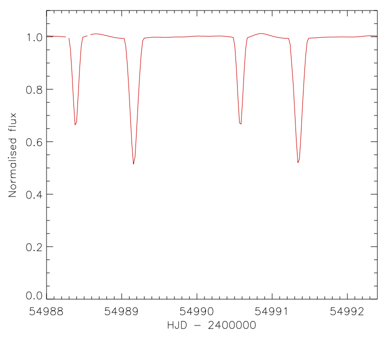
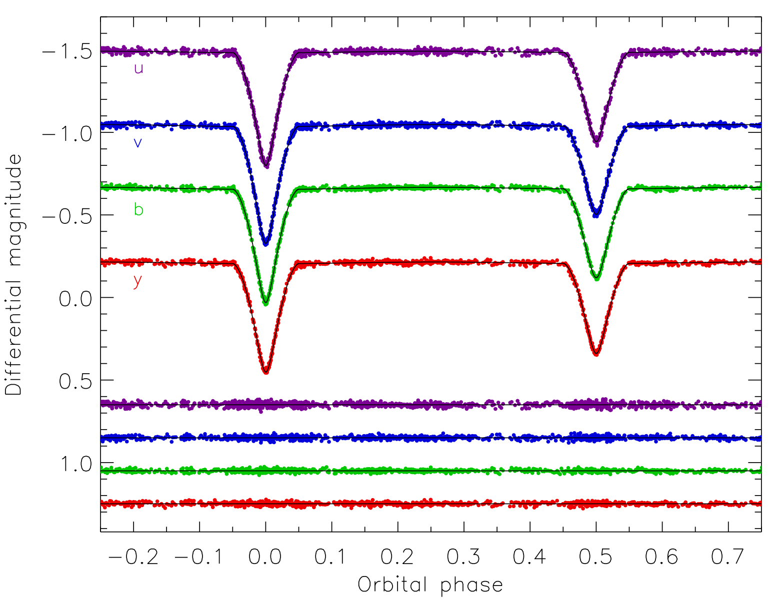
- Contrast Kepler-6 with a *Kepler* EB
- Are they worth bothering with?





The importance of eclipsing binaries



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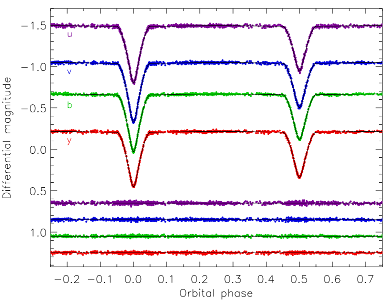

WW Aurigae (Southworth et al., 2005MNRAS.363..529S)

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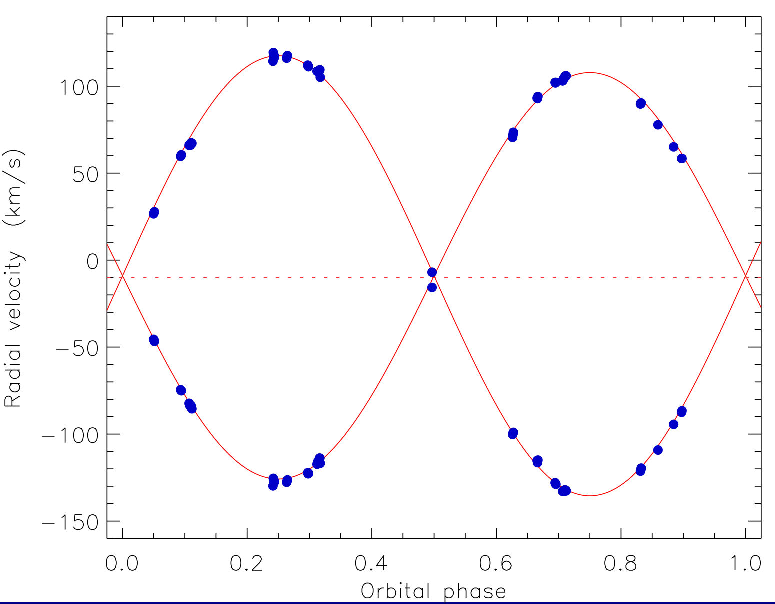

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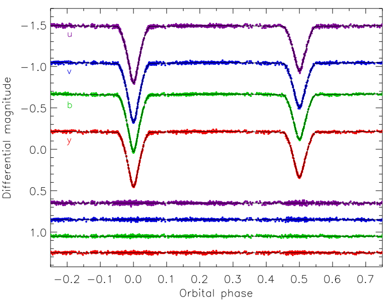

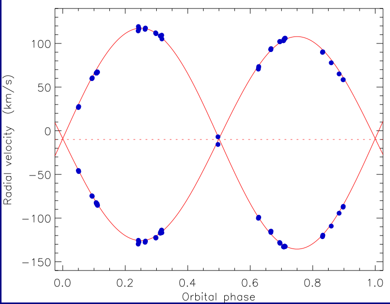

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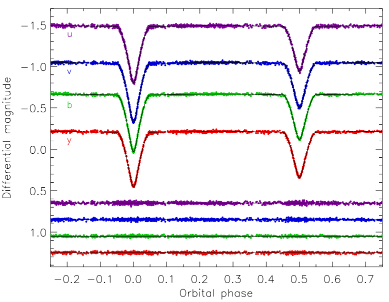

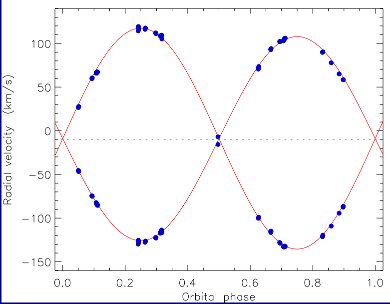

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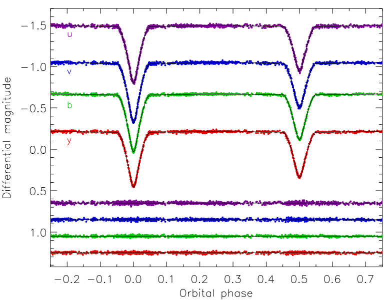

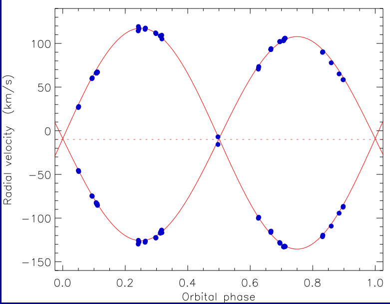

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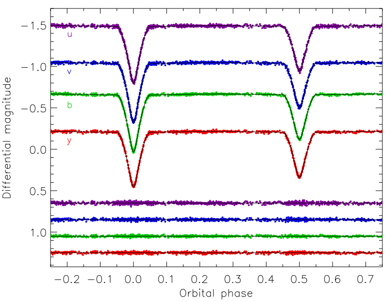

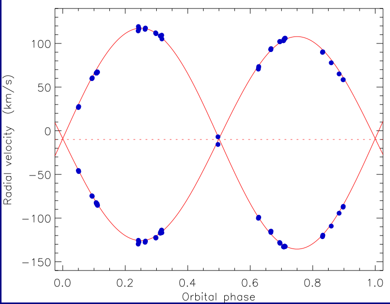

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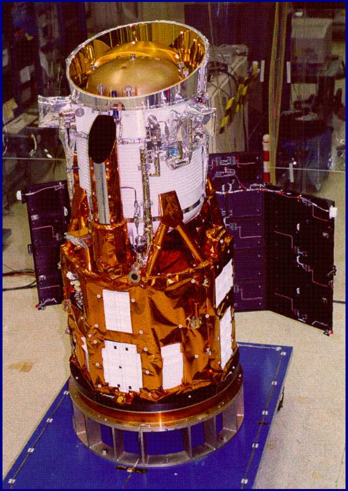
  - better photometry
  - high duty cycle
  - fewer systematic effects



WIRE satellite

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  - MOST (intended for one target at once)
  - CoRoT (small f.o.v., 10^4 targets)
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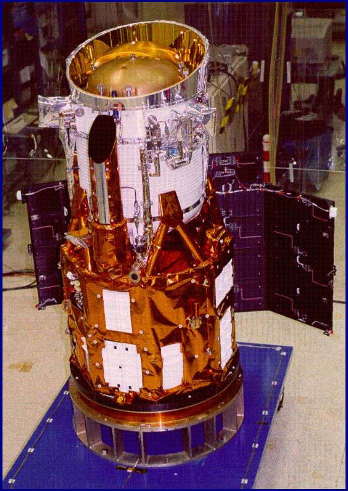

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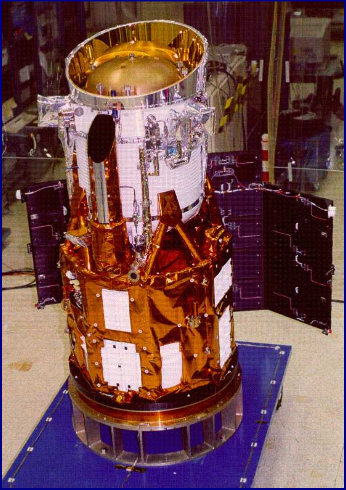
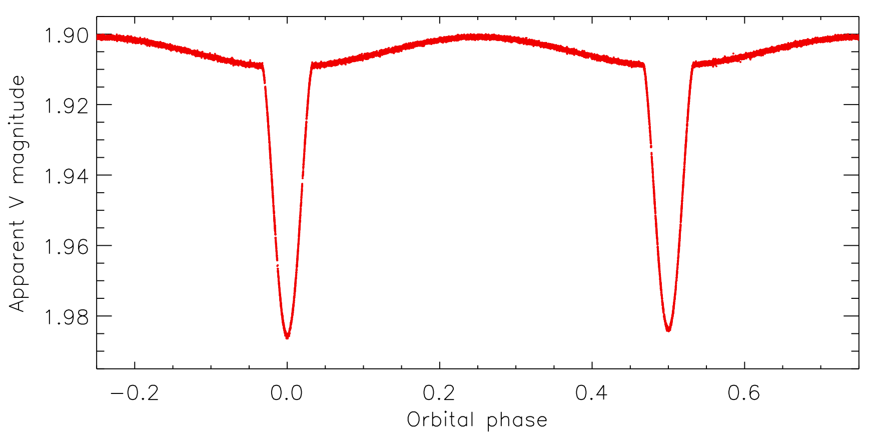
- The WIRE satellite:
  - launched in 1999 to survey galaxies
  - main mission failed (coolant loss)
  - star tracker used as fast photometer



WIRE satellite

WIRE satellite photometry of β Aurigae



- β Aurigae ($V = 1.9$) as seen by WIRE in April 2006
- Modelled using my JKTEBOP code: masses to 1.2% and radii to 0.7%
- Southworth, Bruntt & Buzasi (2007A+A...467.1215S)

The *Kepler* satellite

- Launched in March 2009 by NASA
  - 0.95 m diameter Schmidt telescope
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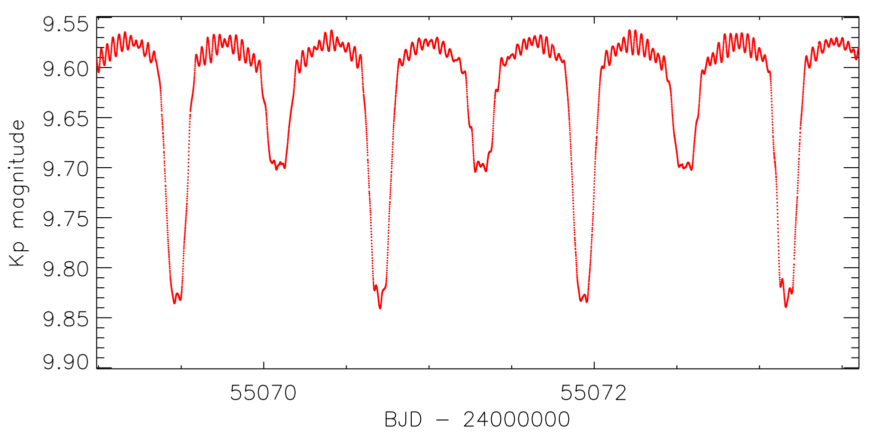
- Additional science 2: asteroseismology
  - *Kepler* Asteroseismic Consortium (KASC) for all pulsation types
  - WG9 deals with the binary systems in the KASC target list

KIC 10661783: an oEA system



- Total eclipses and multiperiodic δ Scuti pulsations
- *Kepler* short cadence for 27 days + SuperWASP data in 2004-8
- $V = 9.568$, orbital period = 1.231 days
- Goal: mass and radius to 1% then mode ID of pulsations

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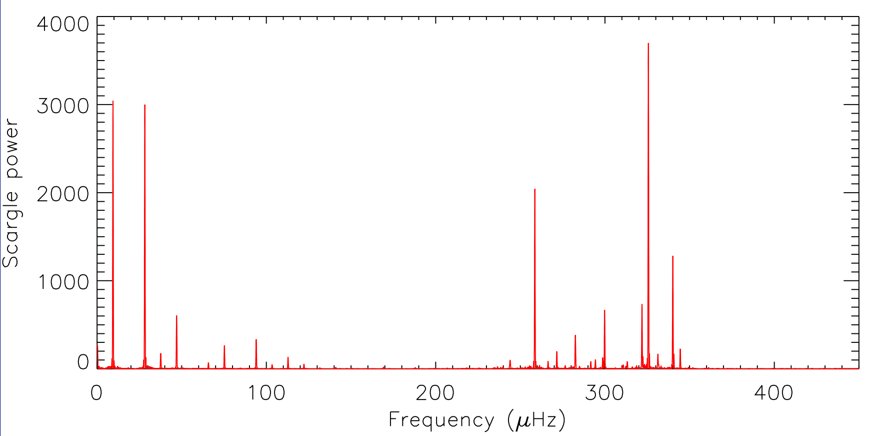

- Remove the eclipses and see what's left
- 55 frequencies found in the interval 200–350 μHz (18–31 $\mathrm{c\,d^{-1}}$)
- Previous best: 8 independent frequencies in Y Cam
(Rodríguez et al. 2010MNRAS.408.2149R)

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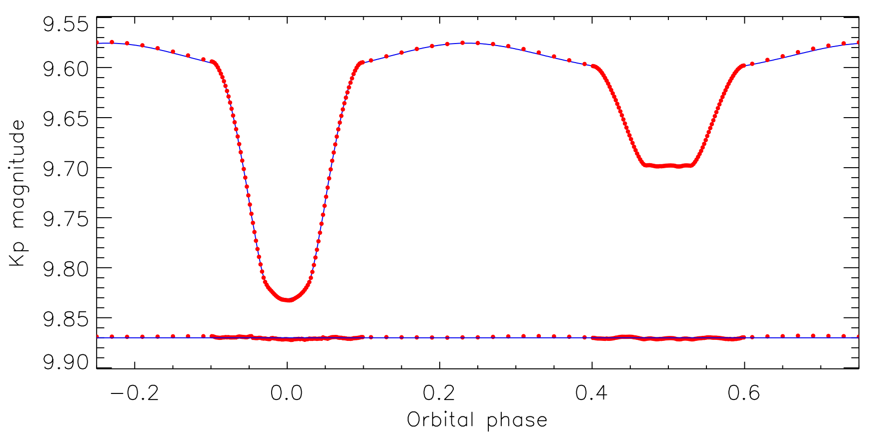
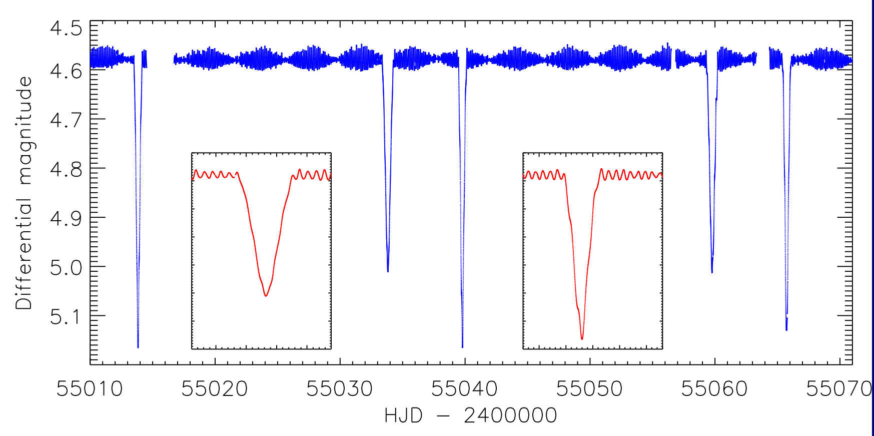


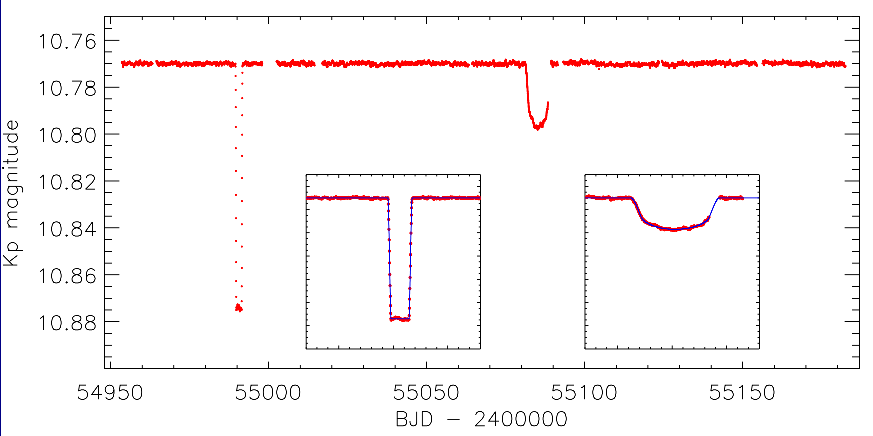
- Remove the frequencies and fit the eclipses with Wilson-Devinney code
- Semi-detached solution favoured by spectroscopic mass ratio: oEA
- Southworth, Zima, Aerts et al. (MNRAS, arXiv:1102.3599)

KIC ???????: eccentric and δ Scuti



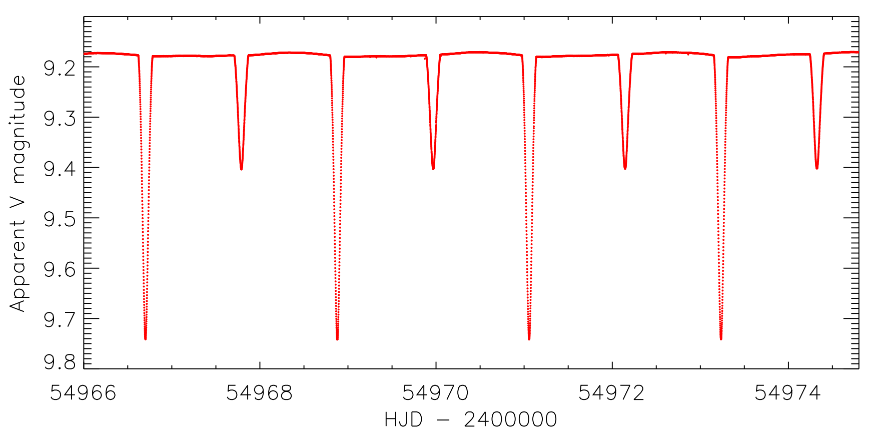
- $e = 0.48$ and multiperiodic δ Scuti pulsations
- *Kepler* short-cadence photometry for 3 months
- $V = 9.273$, orbital period = 25.95 days

KIC 8410637: a giant eclipsing binary



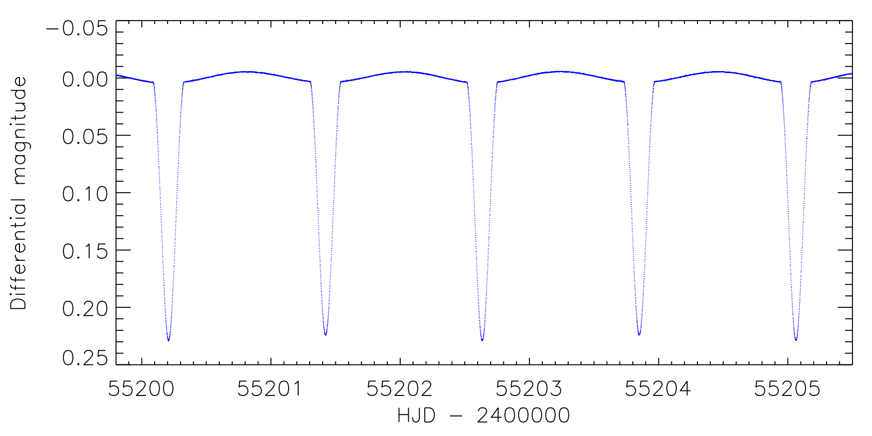
- Primary is a giant $(T_{\mathrm{eff}} = 4650,\ \log g = 2.7)$ with solar-like oscillations
- Eccentric orbit with period greater than one year
- Hekker et al. (2010ApJ...713L.187H)

KIC ???????: a late-type eclipsing binary



- $V = 9.179$ spectral type = F8 V + G8 V period = 2.178 days
- Candidate for solar-like oscillations ⇒ calibrate asteroseismology
- 1 month *Kepler* short cadence data + new observations ongoing

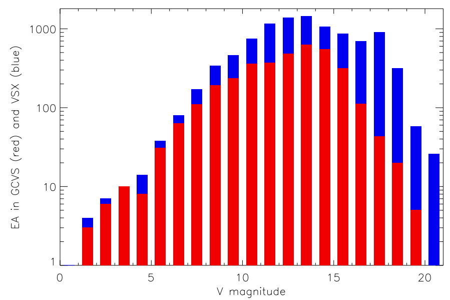
KIC ???????: a simple eclipsing binary



- $V = 10.815$ spectral type = F dwarf period = 2.428 days
- Candidate for solar-like oscillations
- 1 month *Kepler* short cadence data shows very clean variability

The brightest eclipsing binaries

- Histogram of known "EA" objects
  - blue: AAVSO *Variable Star Index* (VSX)
  - red: *General Catalogue of Variable Stars*



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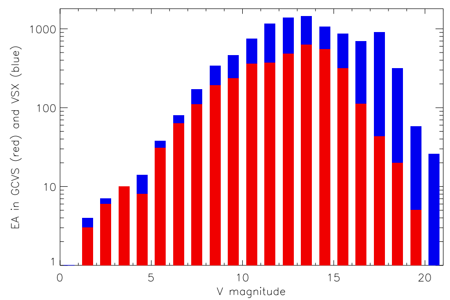
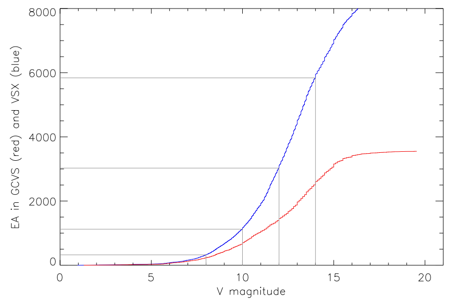
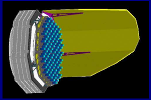


- How many at what magnitude?
  - $V = 8$: 320 EA
  - $V = 10$: 1100 EA
  - $V = 12$: 3000 EA
  - $V = 14$: 5900 EA



Comparing CoRoT, *Kepler* and PLATO



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Mirror diameter	27 cm	95 cm	32×12 cm
Number of stars	c.150 000	156 000 $\searrow$	400 000 ?
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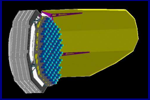

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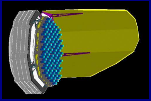

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- PLATO: more stars, brighter stars, higher sampling

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- Likely science areas:
  - structure and evolution of massive stars
  - radius discrepancy of low-mass stars
  - pulsations in eclipsing binaries
  - calibrate asteroseismology
  - distance scale

John Southworth, Astrophysics Group, Keele University