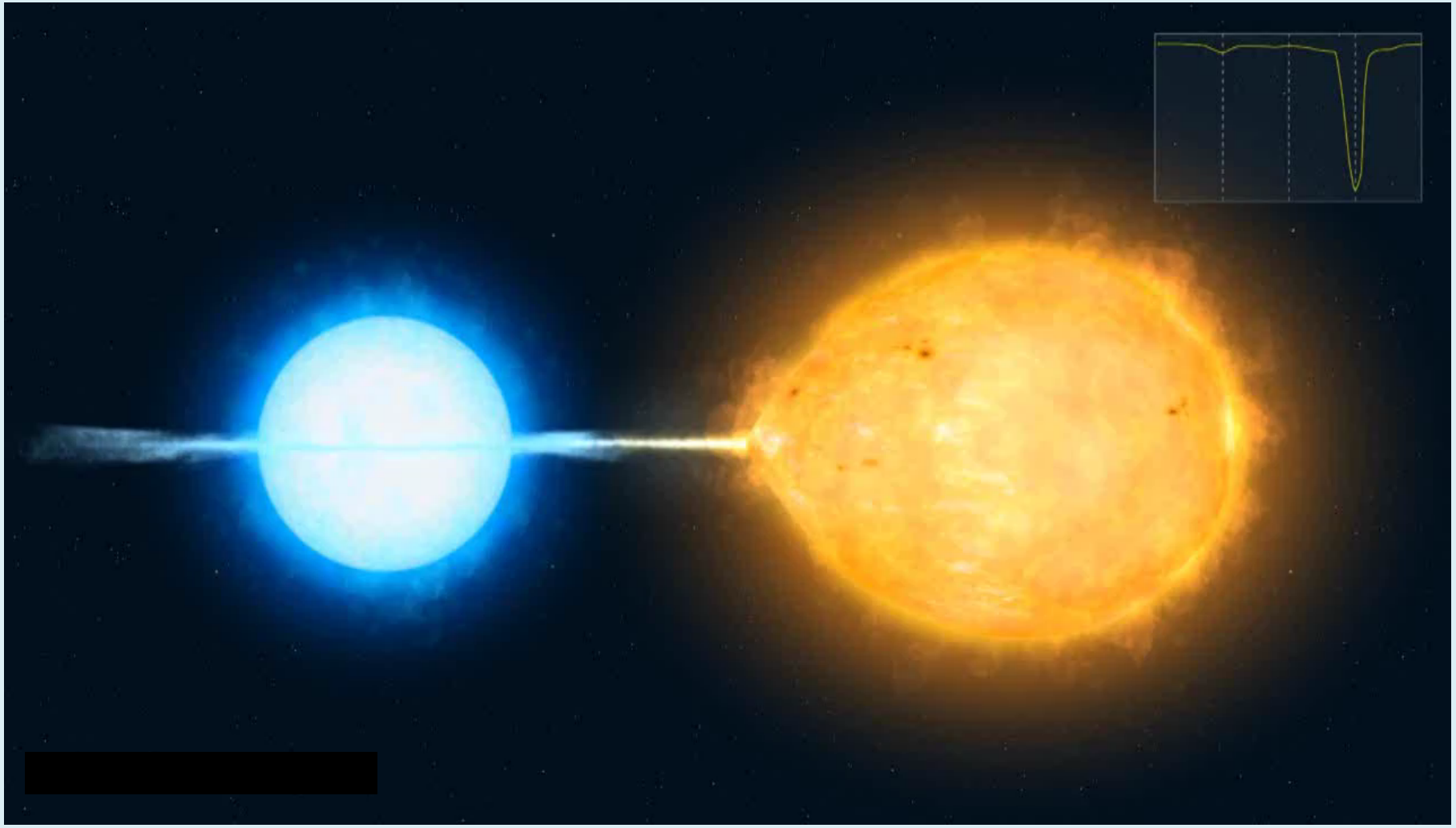
Eclipsing Binaries (EBs)



Max Moe (Einstein Postdoctoral Fellow - Steward Observatory)

Arizona Robotic Telescope Network Workshop - January 18, 2018

EB Surveys

Recent:

Kepler: 2,900 EBs (Kirk+2016)

OGLE: Magellanic Clouds - 49,000 EBs (Pawlak+ 2016);
Galactic Bulge - 451,000 EBs (Soszynski+ 2017)

Current/Upcoming:

Gaia: ~5 million EBs (Eyer+ 2015)

LSST: ~24 million EBs (Prsa+ 2011)

1.3m Warsaw Telescope

VARiability Survey of the TriAngulum GAlaxy (VARSTAGA):

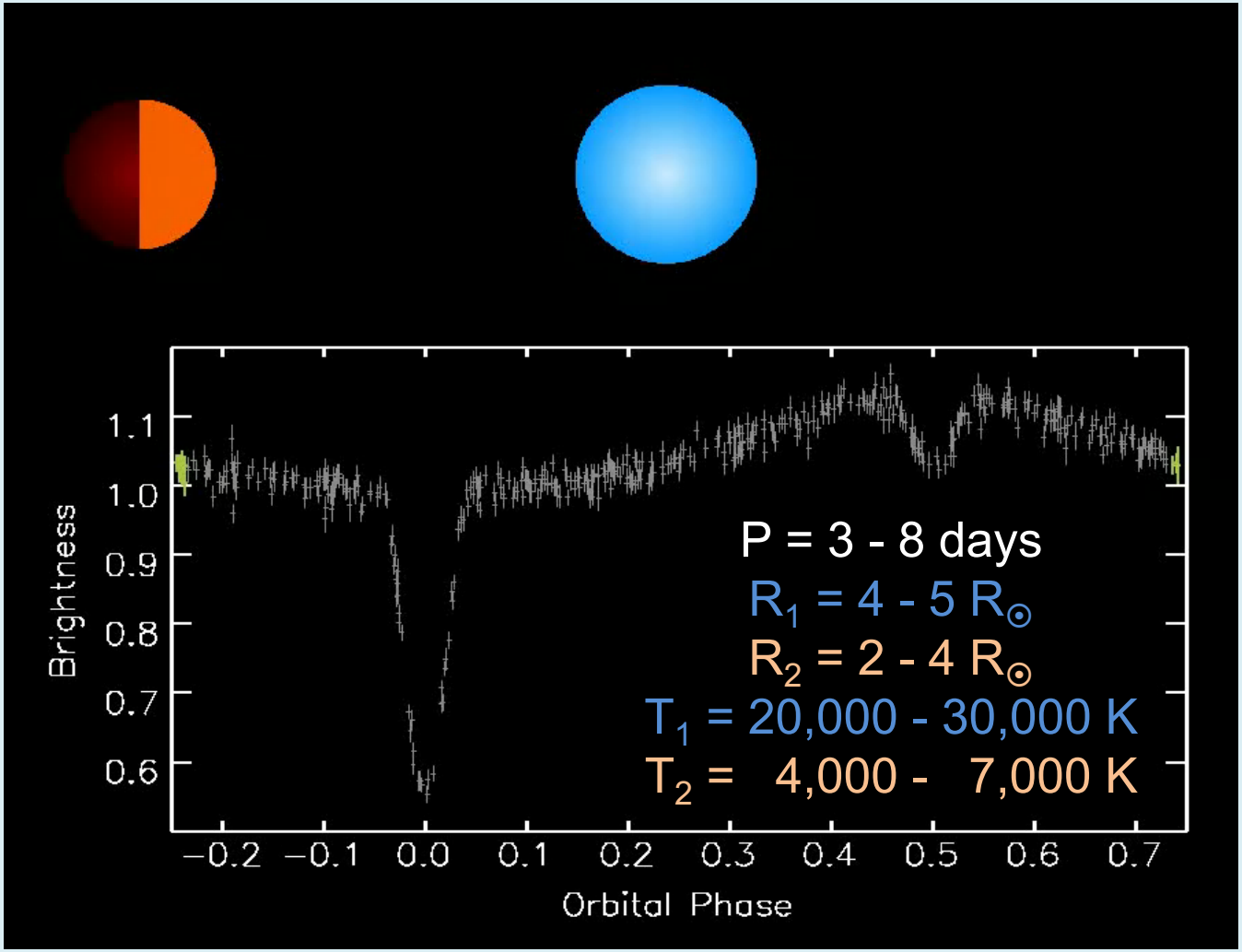
- 200 1-hour epochs with Bok 90Prime (30% complete)
- 2 epochs per quarter-night (45% in i & g each, 5% in u and r each)
- 15 dithered 4-min exposures (fill in chip gaps; correct for i-band fringing)
- precision of $\sigma \lesssim 0.02$ mag at ~22 mag per epoch
- ~10,000 massive EBs

Science with EBs

- Fundamental stellar main-sequence (MS) mass-luminosity-radius relations
- Pre-MS evolutionary tracks (Torres+ 2010)
- Most accurate distances to local group galaxies (Pietrzynski+2013), anchoring cosmological distance scale, H_o, and w (Riess+ 2016)
- Tidal evolution (Moe & Di Stefano 2015b)
- Close Binary Statistics ($F_{close} \propto M_1^{0.7}$; Moe & Di Stefano 2013, 2017)
- Stable mass transfer (Algols; Van Rensbergen+ 2010)
- Triples w/ eclipse timing variations (Borkovits+ 2016)
- Unique phases of formation & evolution:
  - White dwarf + M-dwarf (HW Vir; Lee+ 2009)
  - Cool disk (ε Aur; Kloppenborg+ 2010)
  - MS + pre-MS (Moe & Di Stefano 2015a)

A New Class of Nascent EBs with Extreme Mass Ratios (Moe & Di Stefano 2015a)

Discovered 18 MS + pre-MS EBs with reflection effects:
M_1 = 6 - 20 $M_\odot$, M_2 = 0.8 - 2.4 $M_\odot$ (q = 0.06 - 0.3), & τ = 0.6 - 8 Myr.



Extreme mass-ratio binaries (q < 0.2) are the progenitors of low-mass X-ray binaries and certain types of Type Ia supernovae

Observational Requirements

Discovery Surveys:

- 50 - 500 epochs (single or multi-band)
- Logarithmic cadence (daily - annual)
- For crowded fields, need good seeing / focus across full FOV
  (VARSTAGA: rejecting ~20% of nights with >2.0” seeing at Bok 90Prime)
- Dithered exposures (fill in chip gaps & bad pixels; correct for fringing)

Follow-up (e.g., of *Gaia* and LSST EBs):

- Different bands
- Better sensitivity
- Higher cadence, esp. at particular orbital phase (given known P and t_0)