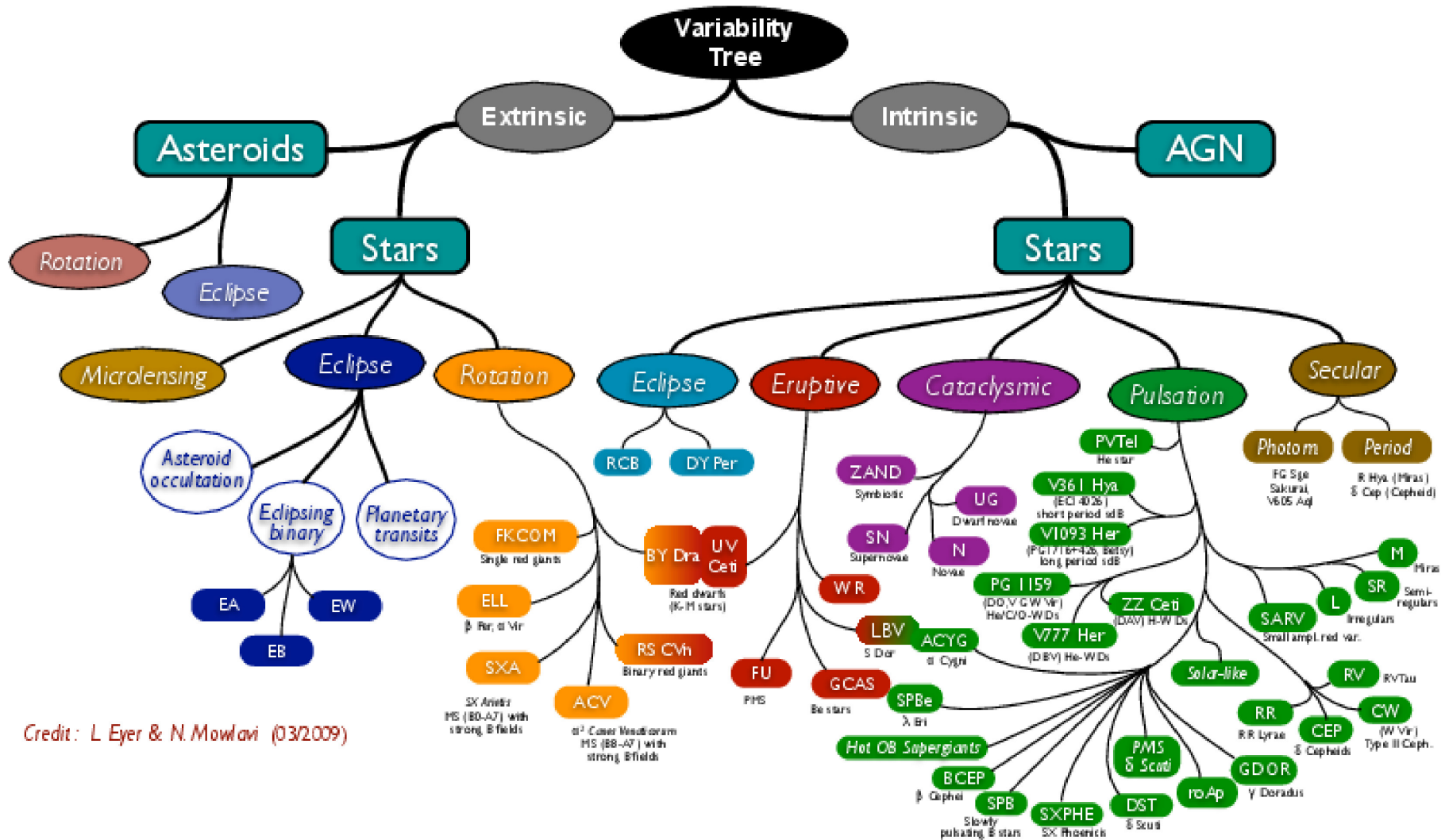


Uzbudljiv svet pulsirajućih zvezda i šta možemo da istražujemo u ovoj oblasti

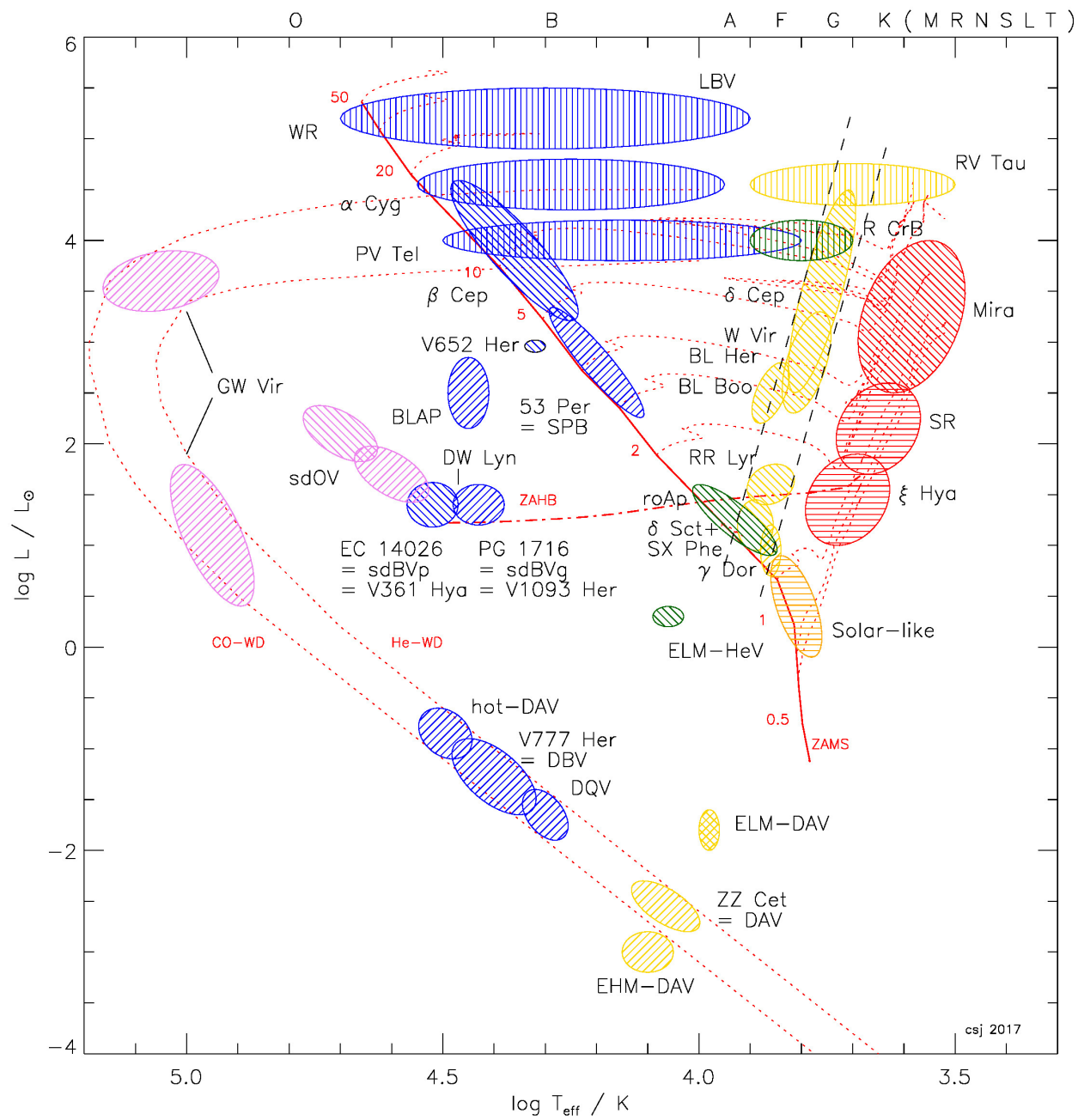
Monika I. Jurkovic

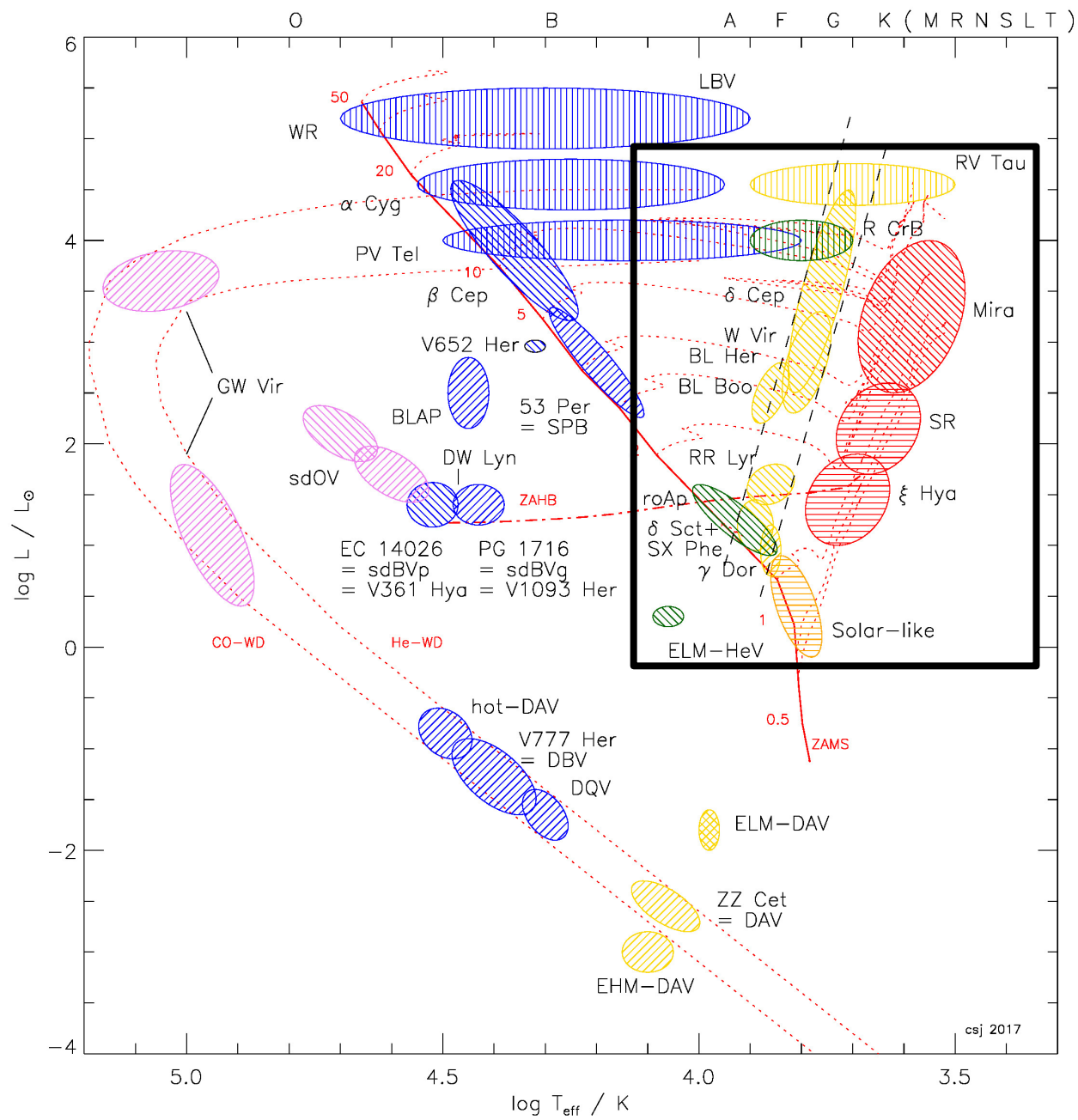
Seminar na Katedri za astronomiju
Matematički fakultet

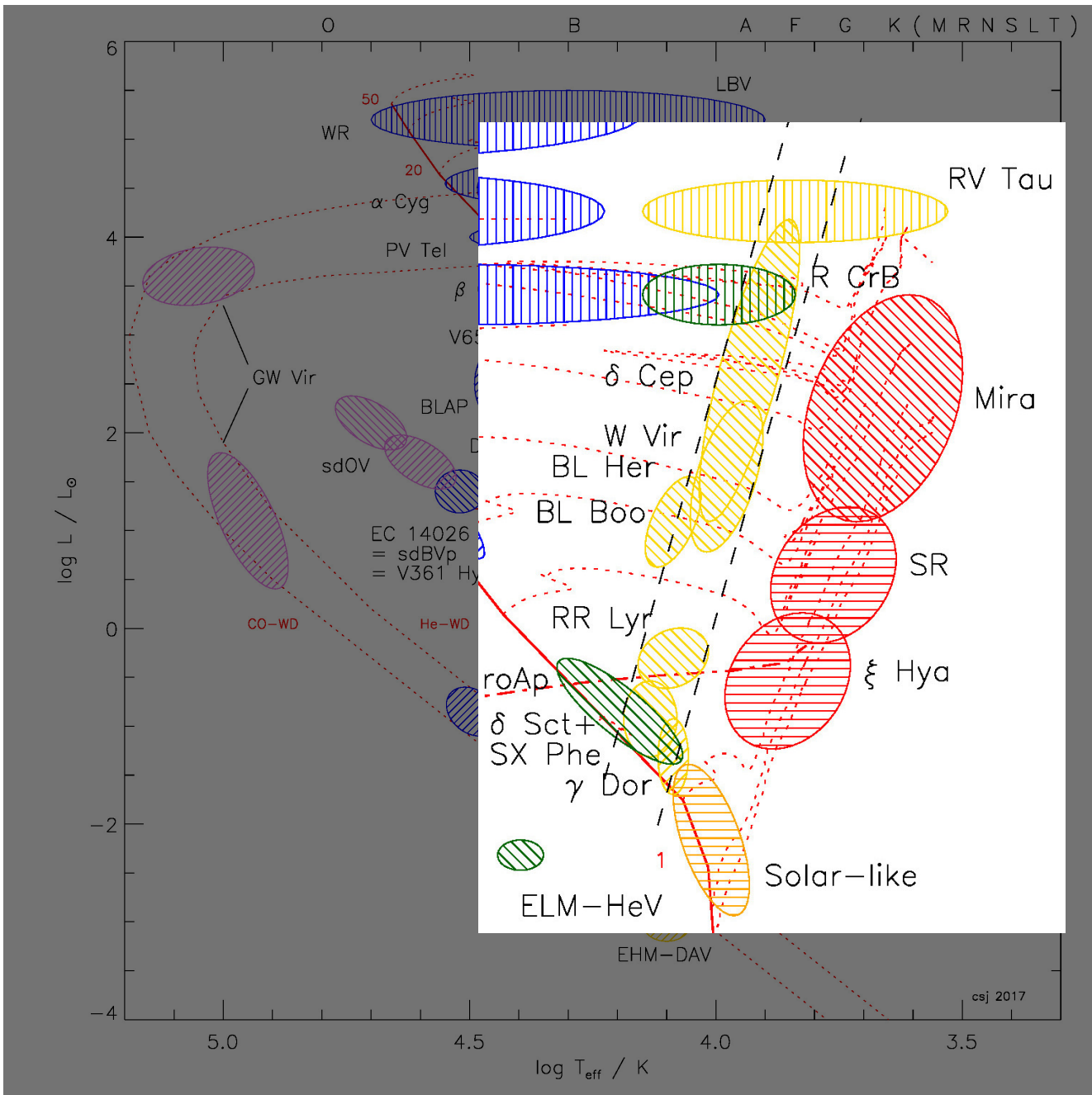
07.05.2019.



Credit: L Eyer & N Mowlavi (03/2009)



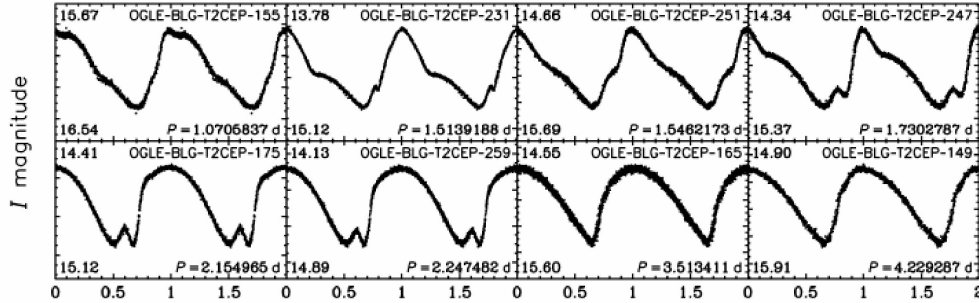




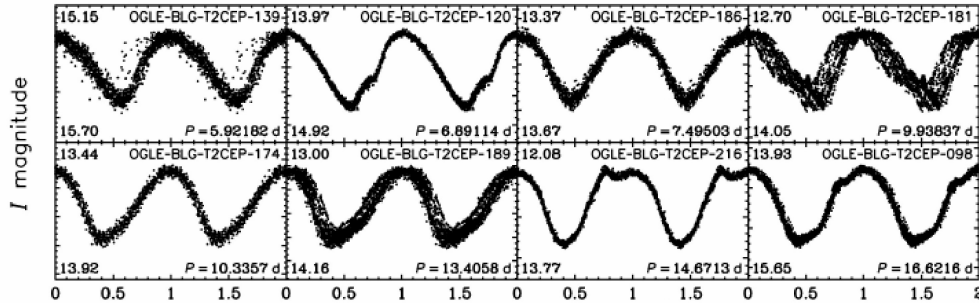
Cefeide tipa II

- Za cefeide tipa II se pretpostavlja da su stare zvezde niske metaličnosti
- Masa: $\sim 0,5 M_{\odot}$
- Starost: više od 10 milijardi godina

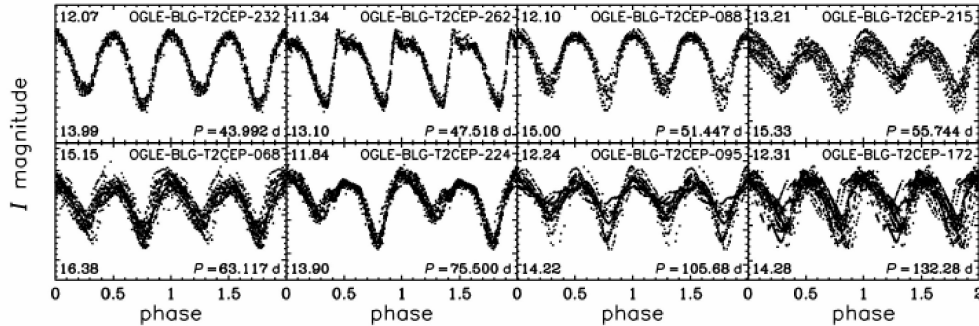
BL Her stars



W Vir stars



RV Tau stars



• Podtipovi:

– BL Herculis

$1 < P \text{ (dana)} < 4 - 5$

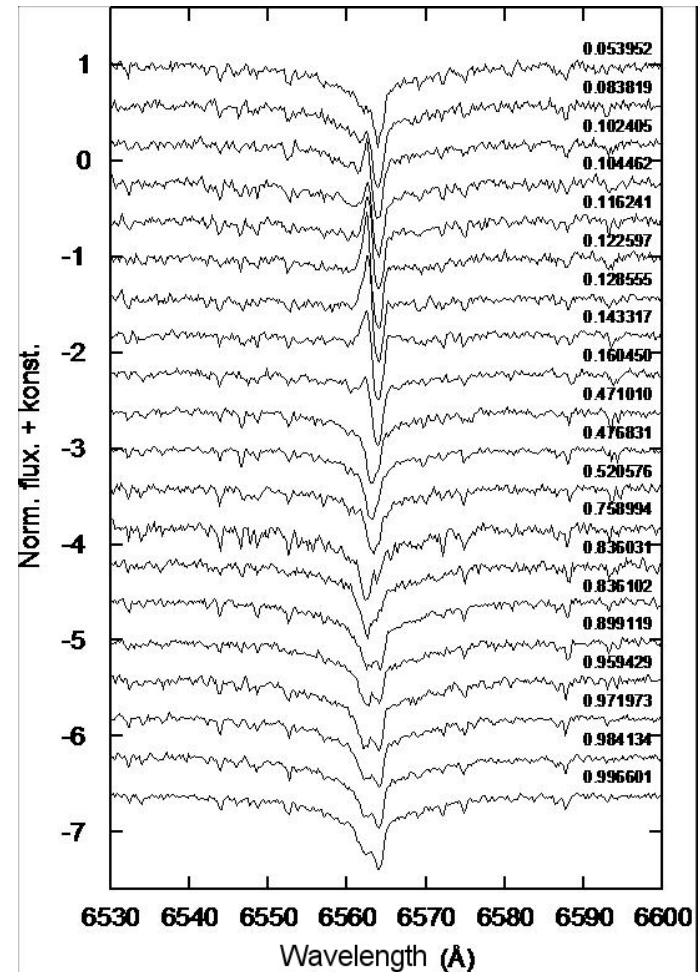
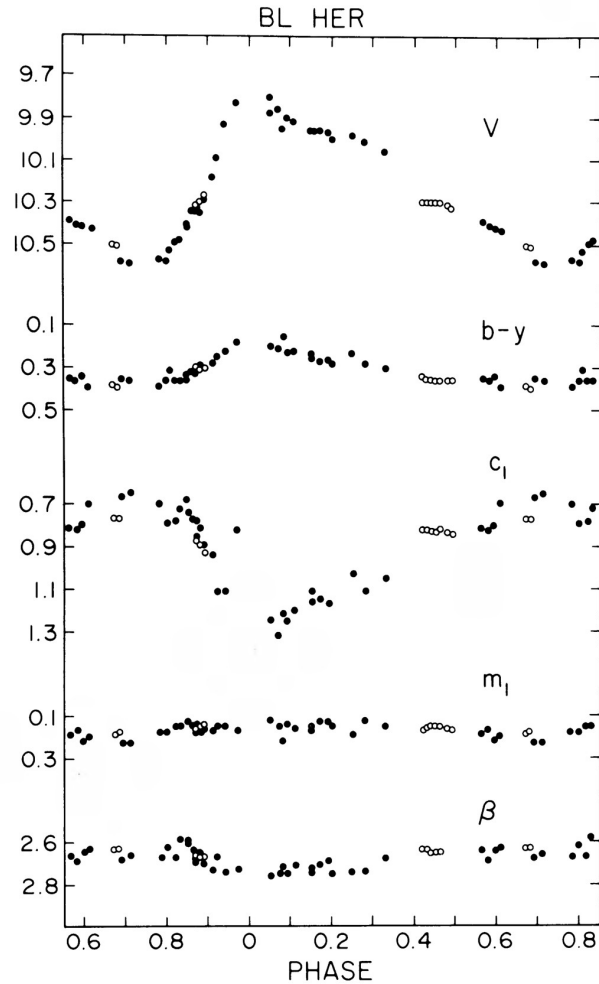
– W Virginis

$4 - 5 < P \text{ (dana)} < 20$

– RV Tauri

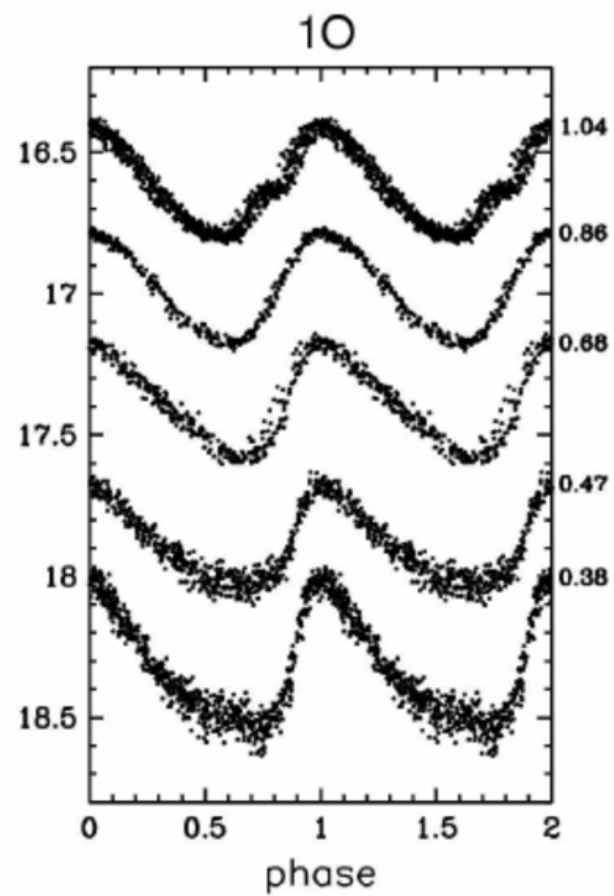
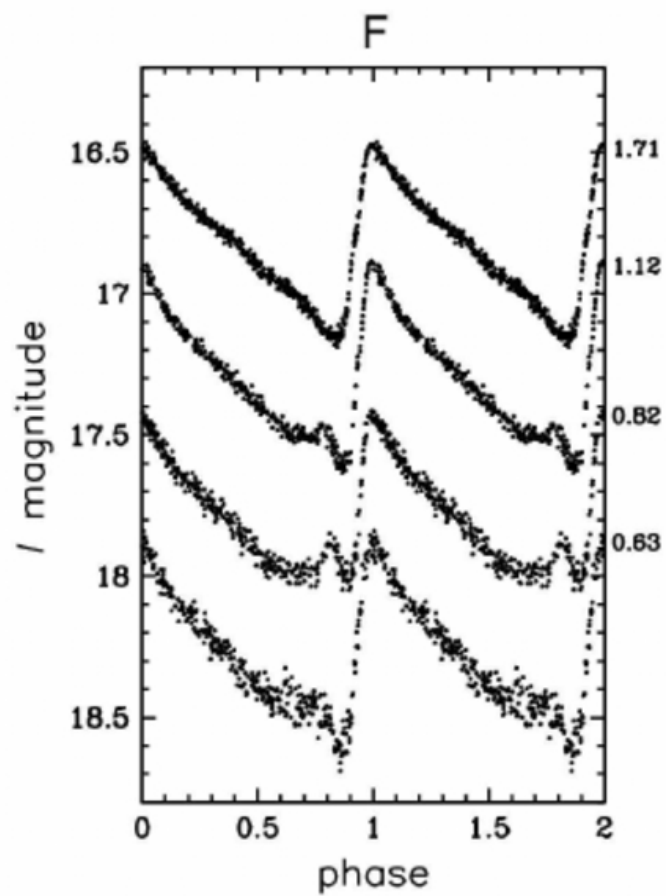
$20 < P \text{ (dana)} < 100,$
 150

Jedan primer: BL Her



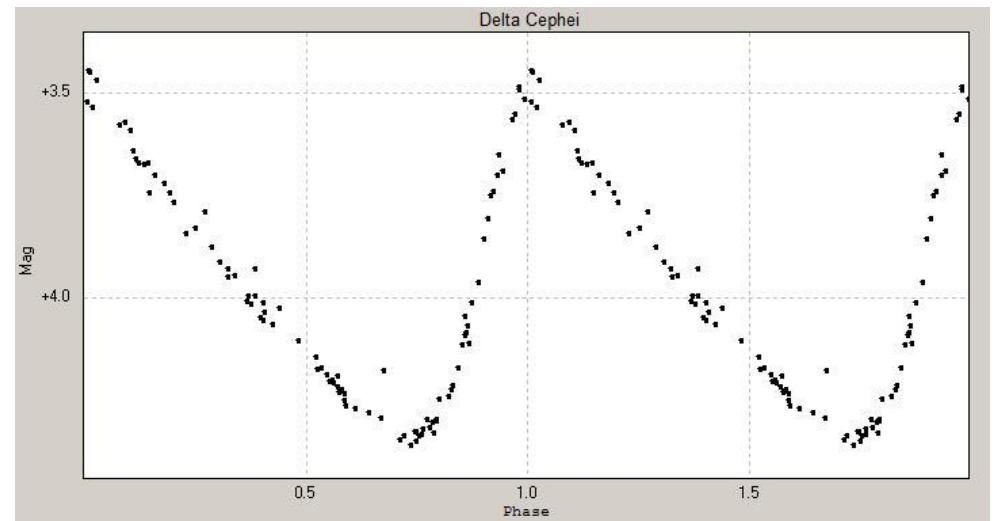
Anomalne cefeide

- Masa: $\sim 1,2 M_{\odot}$
- Starost: 1 – 5 milijardi godina
- Zvezde sa niskom metaličnošću
- Njihovo poreklo je i dalje otvoreno pitanje, pošto zvezde ovih masa (kao što je i naše Sunce) u Mlečnom putu ne bi trebale da imaju nisku metaličnost



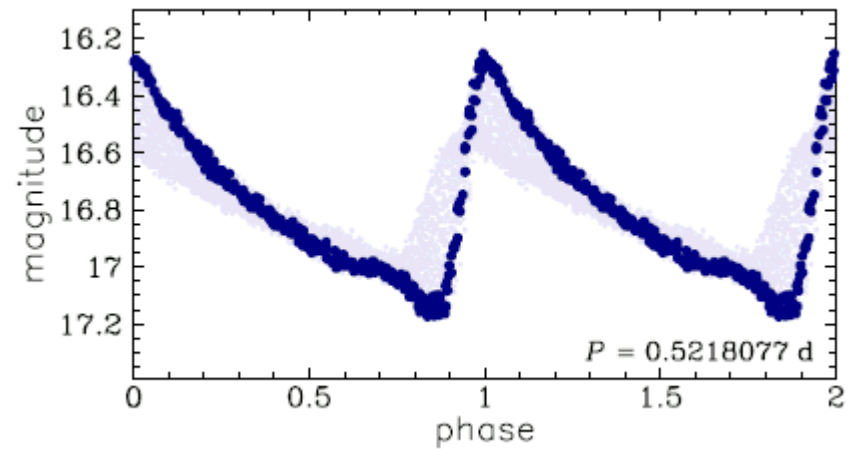
Klasične cefeide

- Period pulsacije:
1 - 100 dana
- Masa: 4 - 20 M_{\odot}
- Pulsiraju u osnovnoj modi i prvoj nadmodi



RR Lyrae promenljive zvezde

- Period pulsacije
0,2 – 2 dana
- Masa: $0,5 M_{\odot}$
- Pokazuju Blaško
efekat

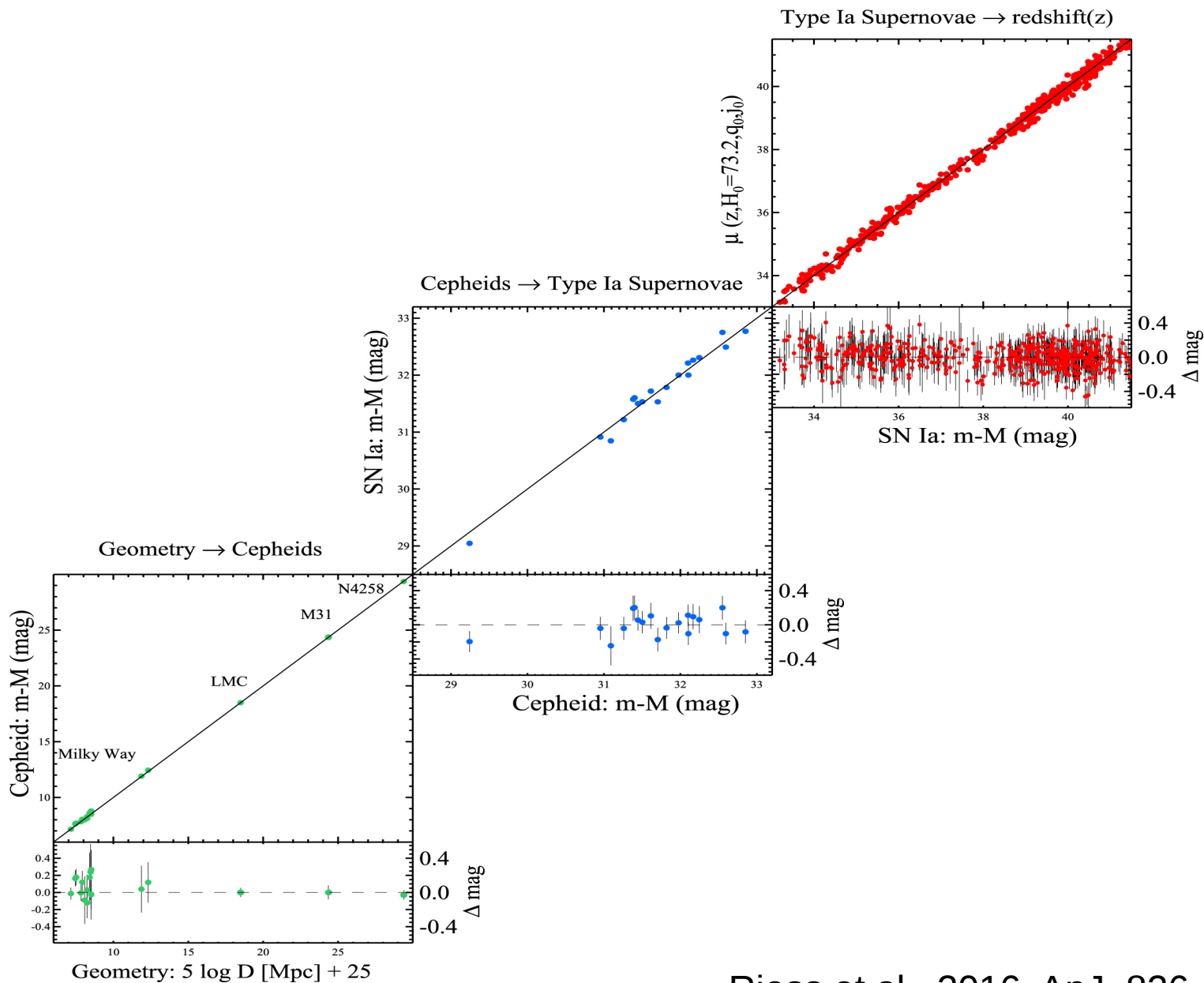


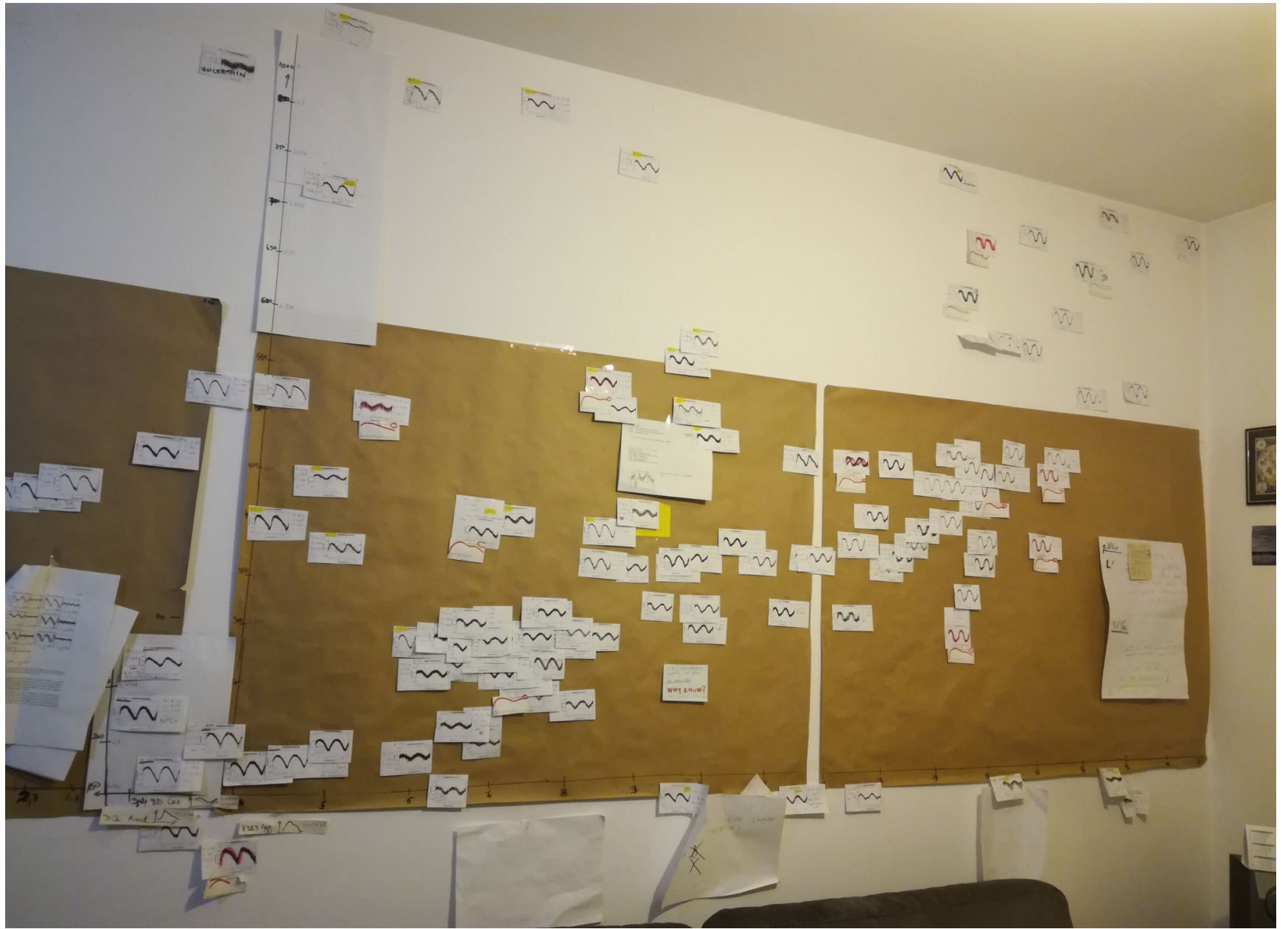
Dugo-periodične promenljive zvezde

- Semiregularne zvezde
- Mira promenljive zvezde
- Nepoznat im je tačan mehanizam pulsacije
- Na HRD se nalaze izvan zone nestabilnosti

Važnost pulsirajućih zvezda

- PL relacija, koja kalibriše galaktičku skalu daljine
- Modeliranje evolucije i pulsacije
- U sledećih nekoliko godina ćemo moći da vidimo ove promenljive i u drugim (susednim) galaksijama što će nam omogućiti da istražujemo stare generacije zvezda – galaktička arheologija, istraživanje nastanka galaksija





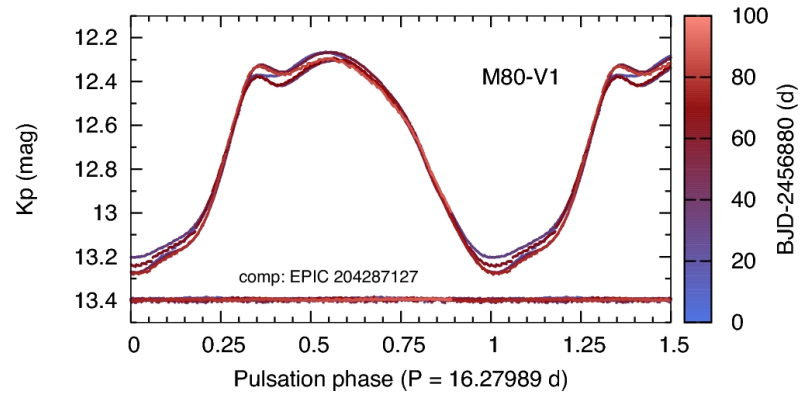
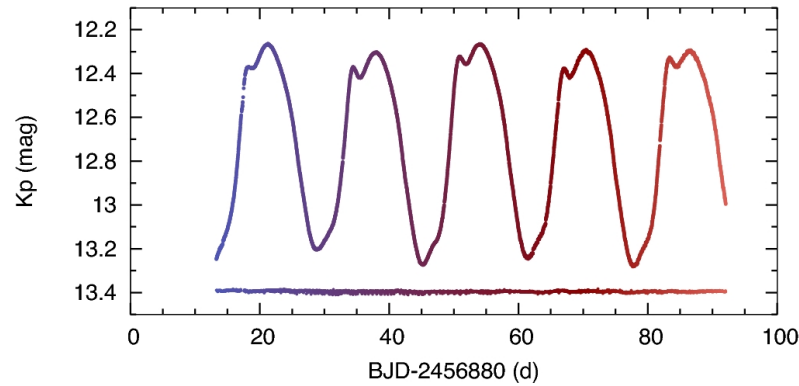
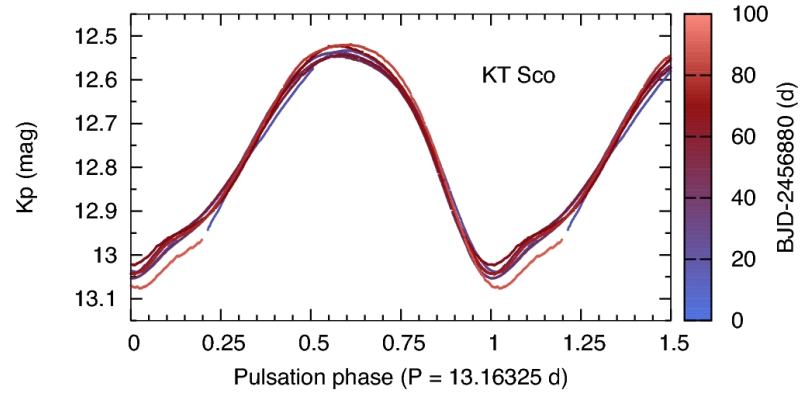
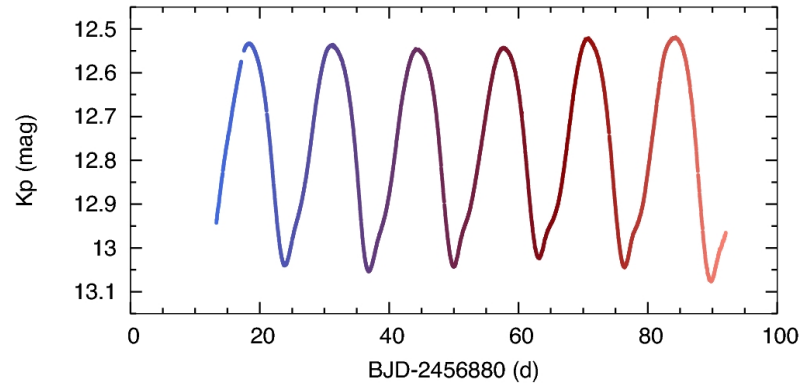
22nd Pulsation conference San Pedro de Atacama 27 NOV - 02 DEC 2016, Chile



Projekti

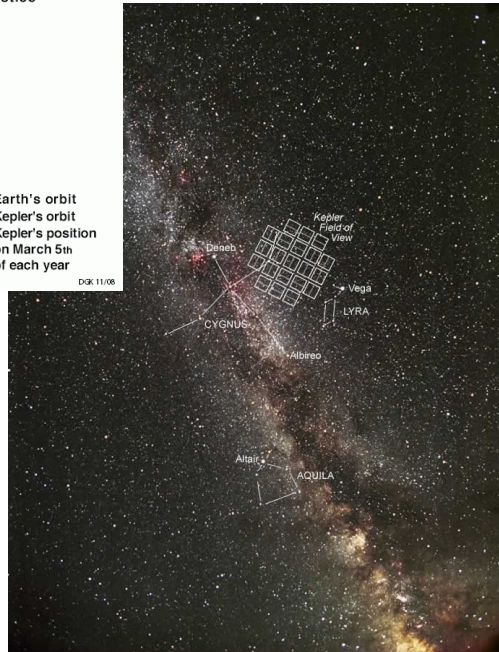
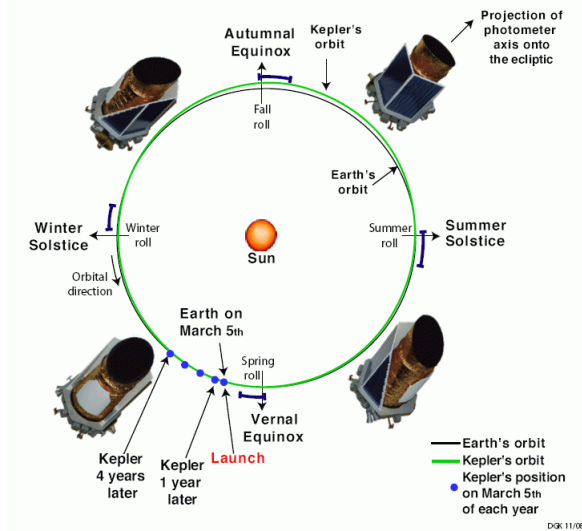
Udvostručenje perioda i druge pulsirajuće
frekvencije kod cefeida tipa II

Zvezde tipa W Virginis KT Sco i M80 V1



Svemirski teleskopi

- Kepler i K2 misija
- TESS



Exoplanet Missions

Hubble¹

Spitzer

Kepler

TESS

JWST²

WFIRST

PLATO

CHEOPS

New Worlds Telescope

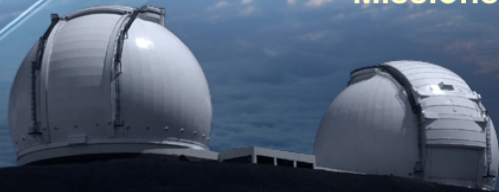
Gaia

Habitable Exoplanet Imager
LUVOIR

CoRoT³

NASA Missions

ESA/European Missions



W. M. Keck Observatory



Large Binocular Telescope Interferometer



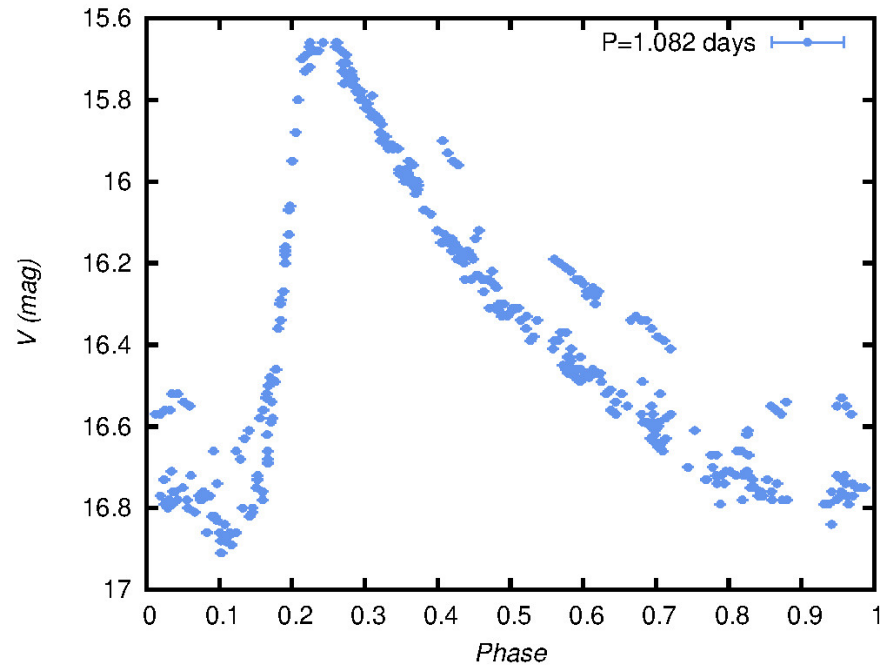
NN-EXPLORE

- ¹ NASA/ESA Partnership
- ² NASA/ESA/CSA Partnership
- ³ CNES/ESA

Ground Telescopes with NASA participation

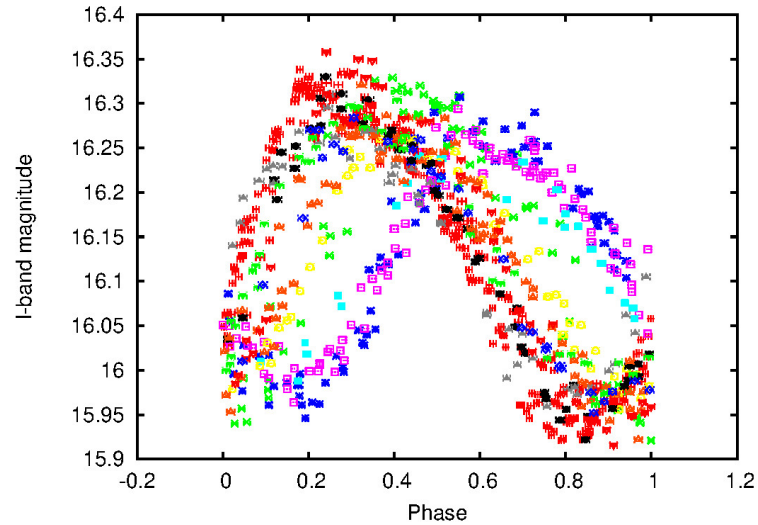
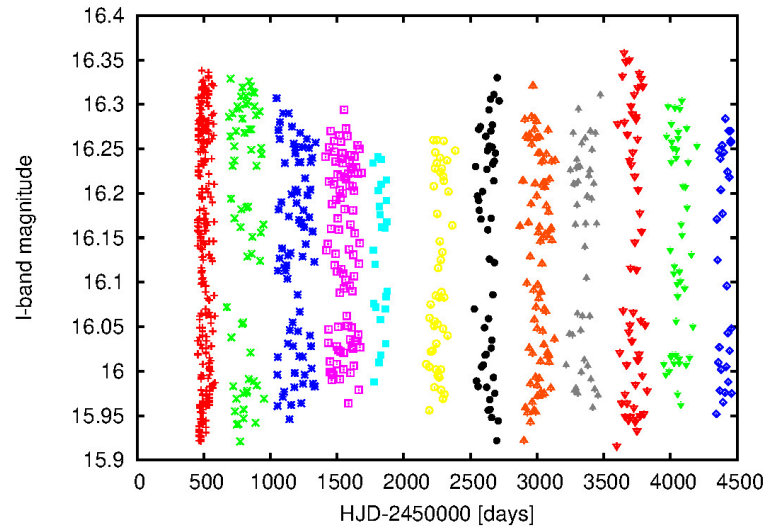
Da li anomalne cefeide imaju Blaško efekat?

FY Vir



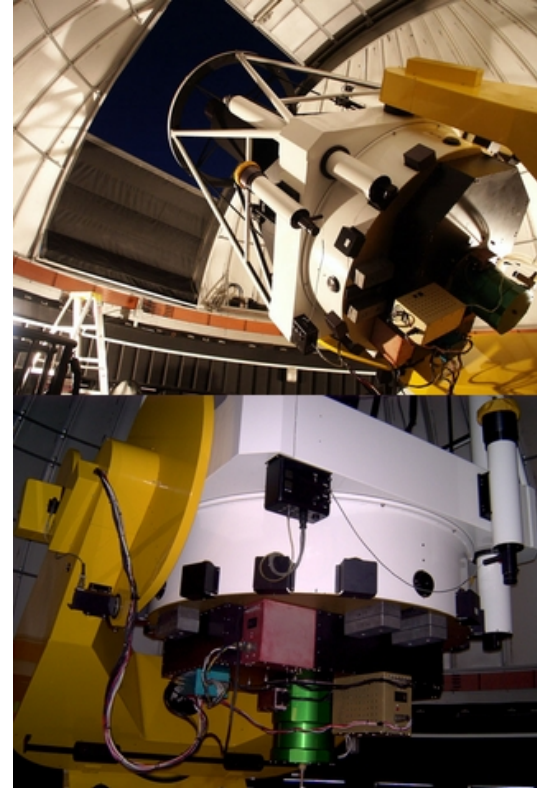
„Shape-shifter“ W Virginis

OGLE-LMC-T2CEP-127



Groenewegen & Jurkovic, "Luminosities and infrared excess in Type II and anomalous Cepheids in the Large and Small Magellanic Clouds", 2017, *A & A*, **603**, A70

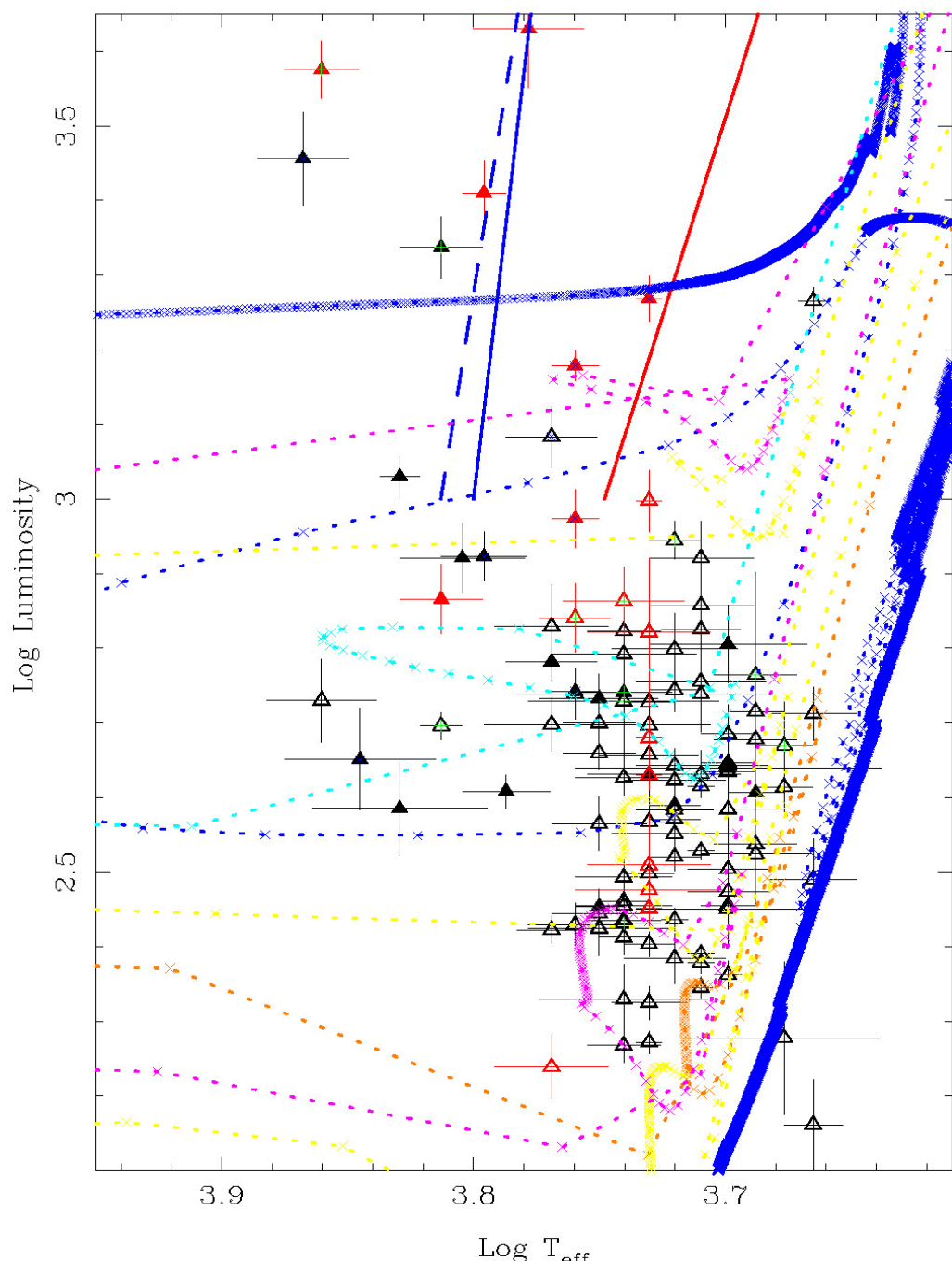
OGLE



- SuperWASP
- NSVS
- ASAS, ASAS-SN
- INTEGRAL
- RAVE

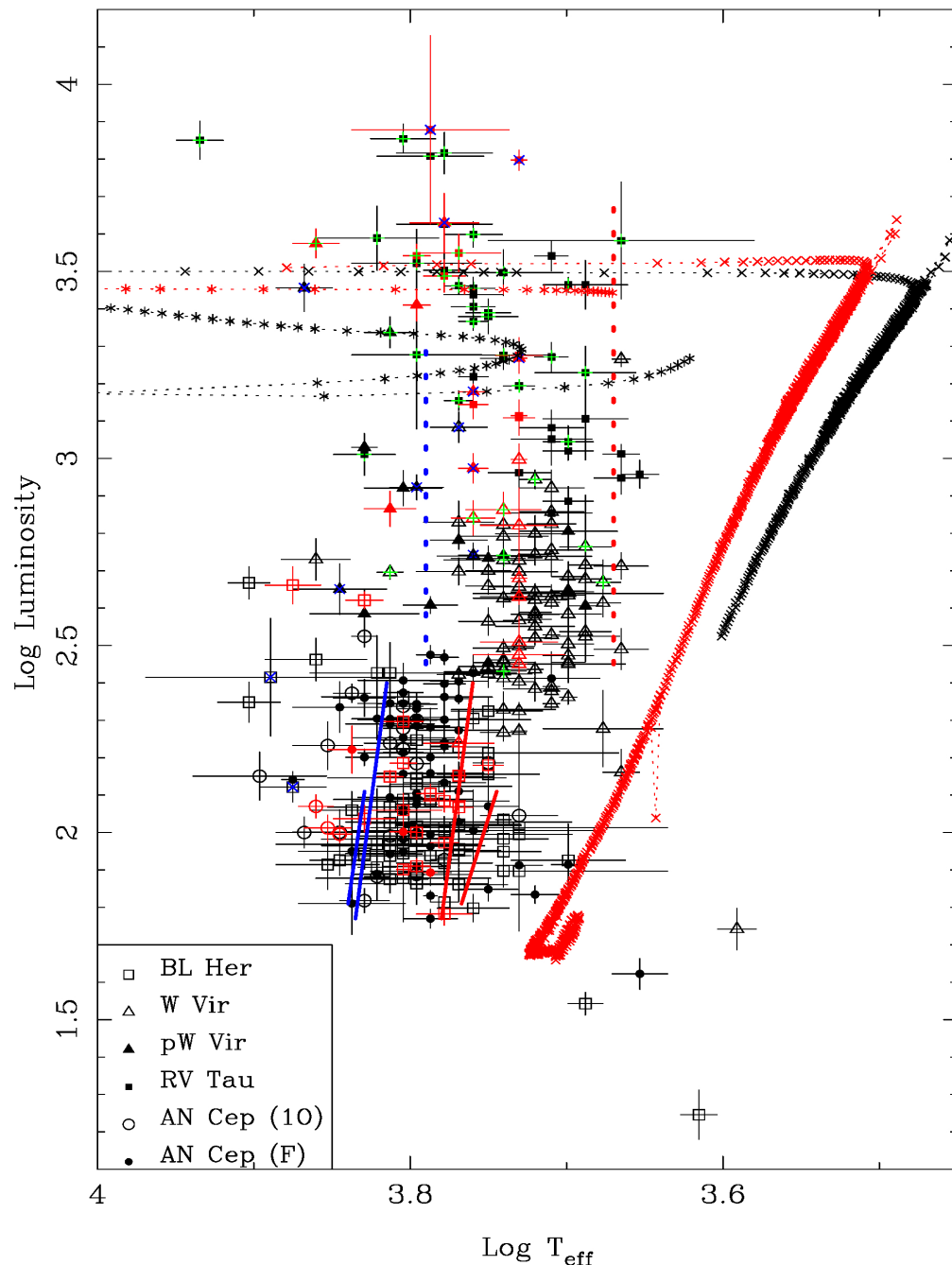
Poreklo zvezde tipa W Virginis

HRD - WVir

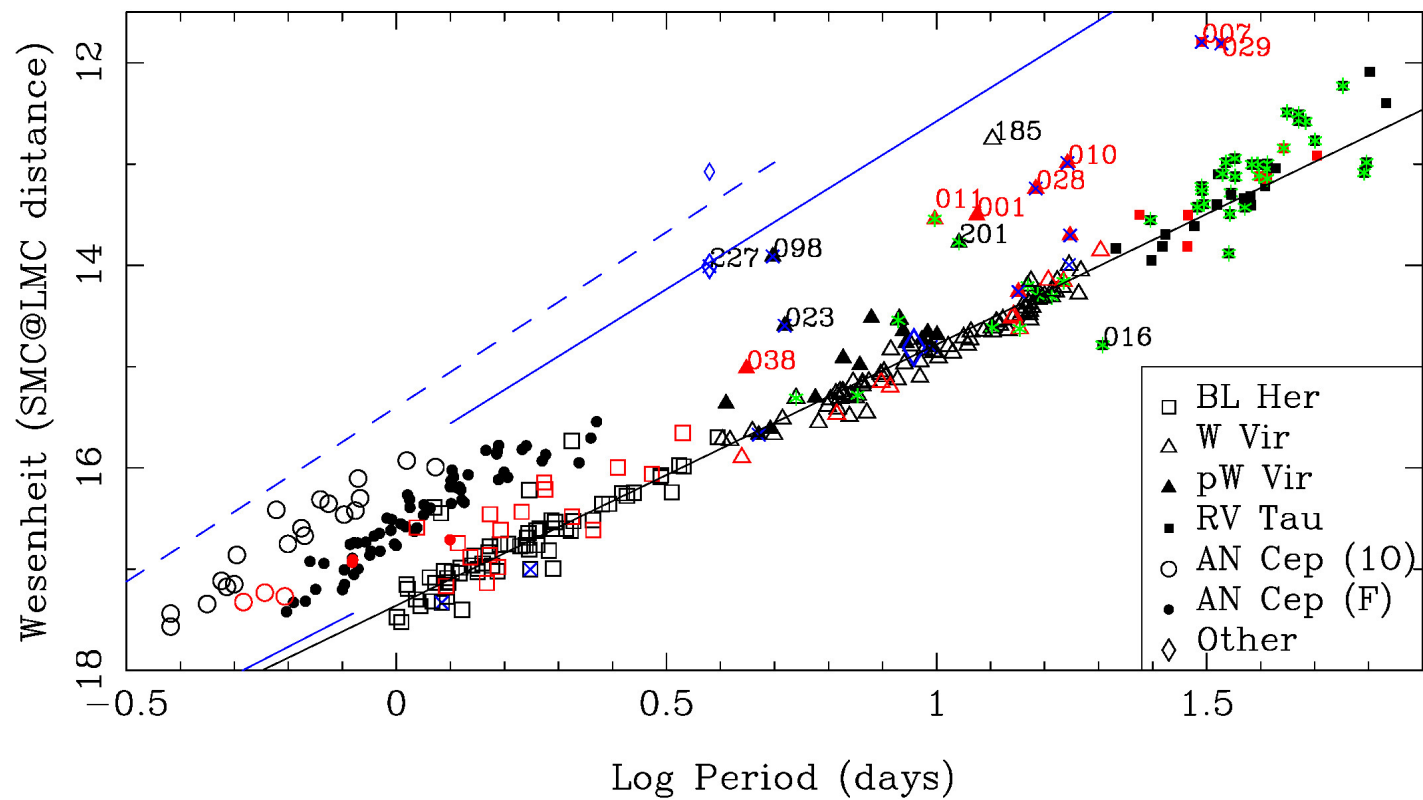


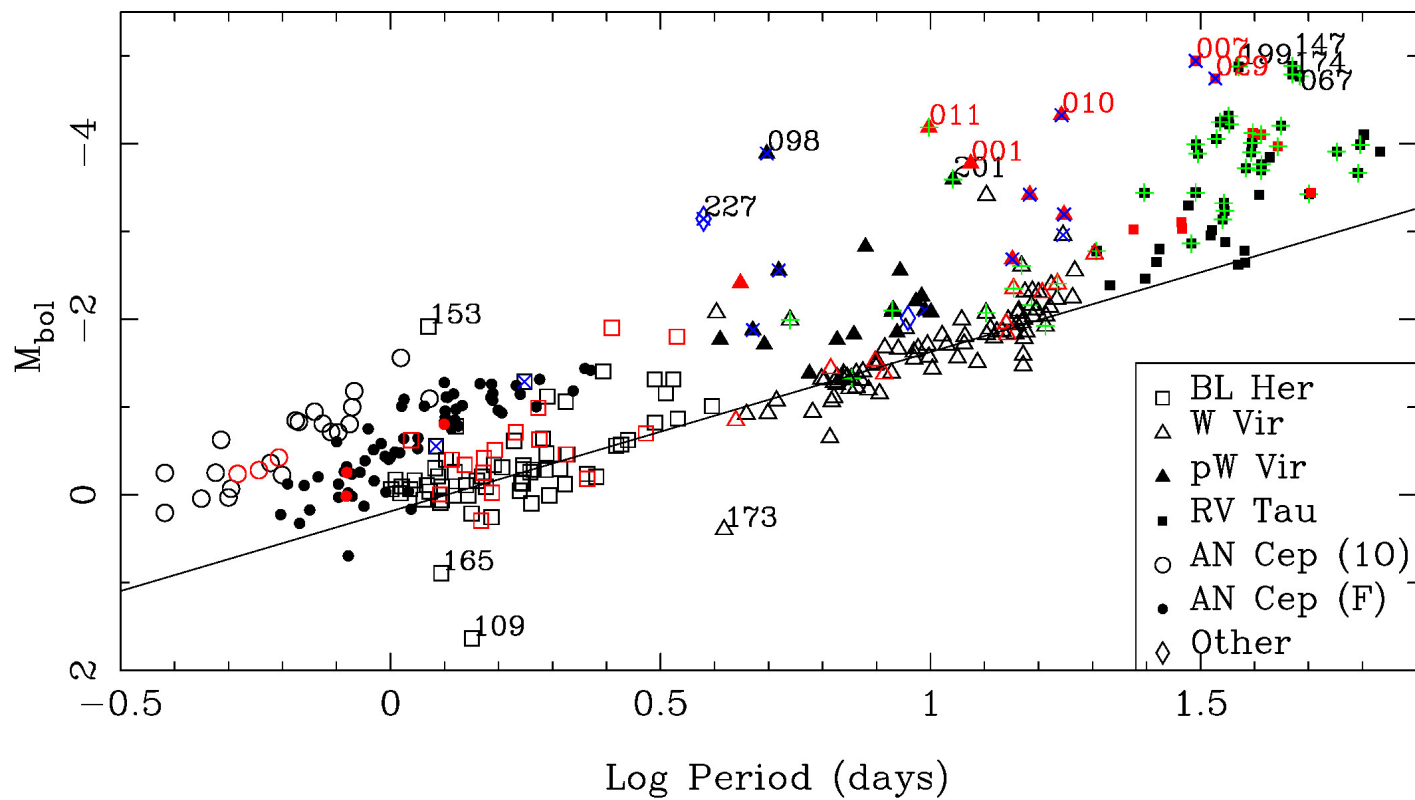
Groenewegen &
Jurkovic, "Luminosities
and infrared excess in
Type II and anomalous
Cepheids in the Large
and Small Magellanic
Clouds", 2017, *A & A*,
603, A70

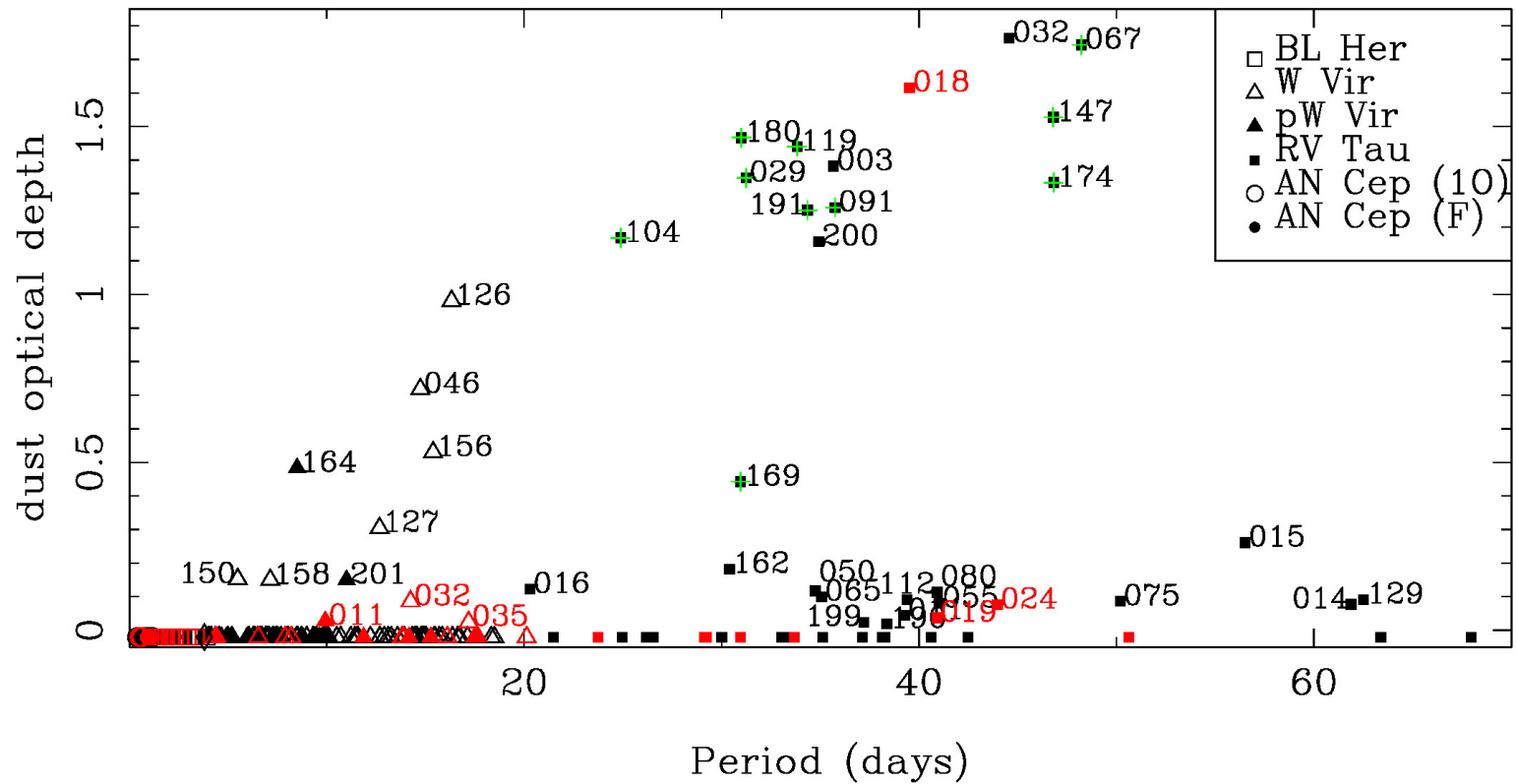
Projekti vezani za zvezde tipa RV Tauri



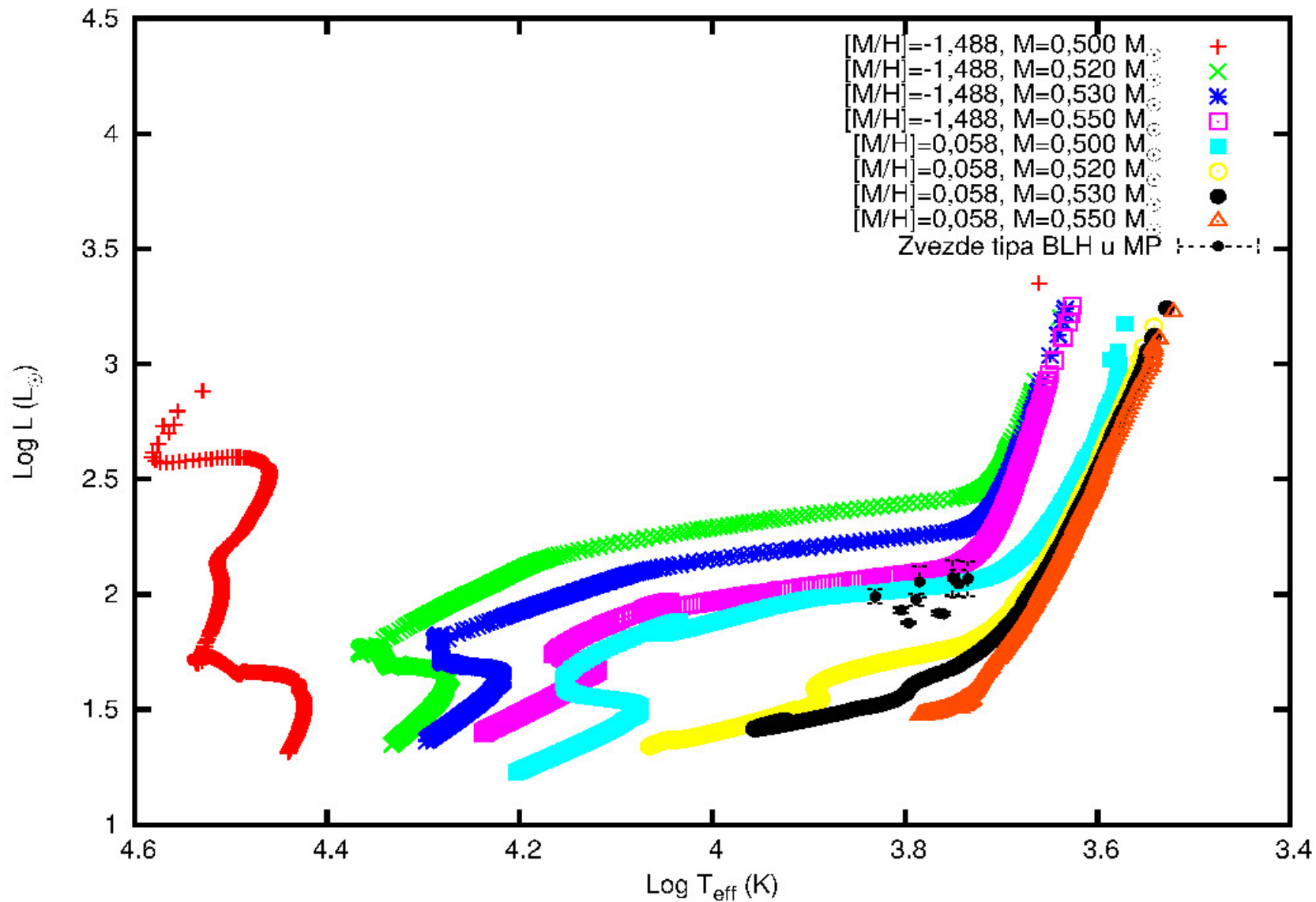
Groenewegen & Jurkovic, "Luminosities and infrared excess in Type II and anomalous Cepheids in the Large and Small Magellanic Clouds", 2017, *A & A*, **603**, A70







Metaličnost cefeida tipa II i anomalnih cefeida

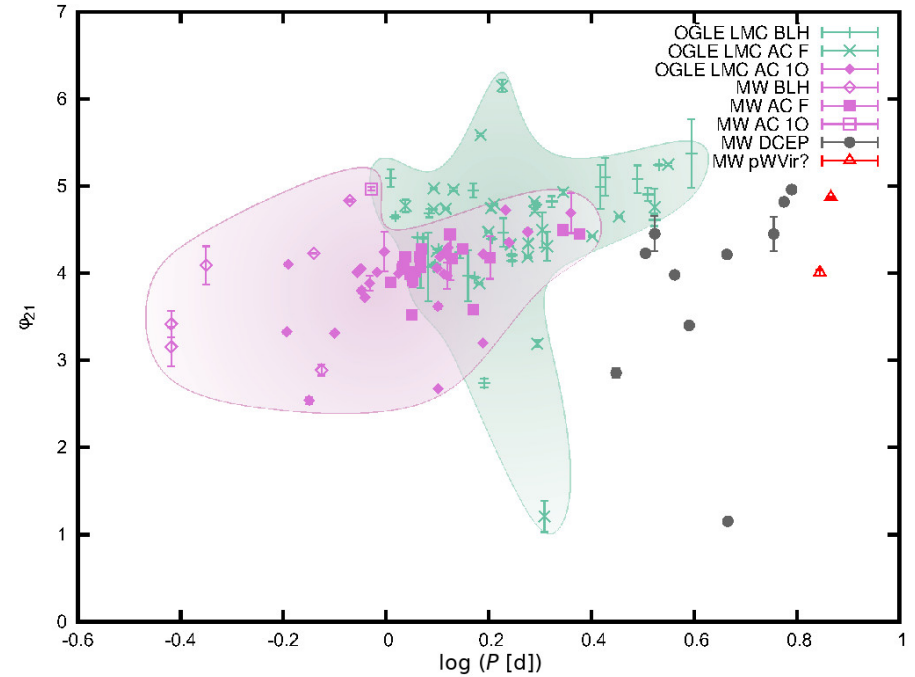
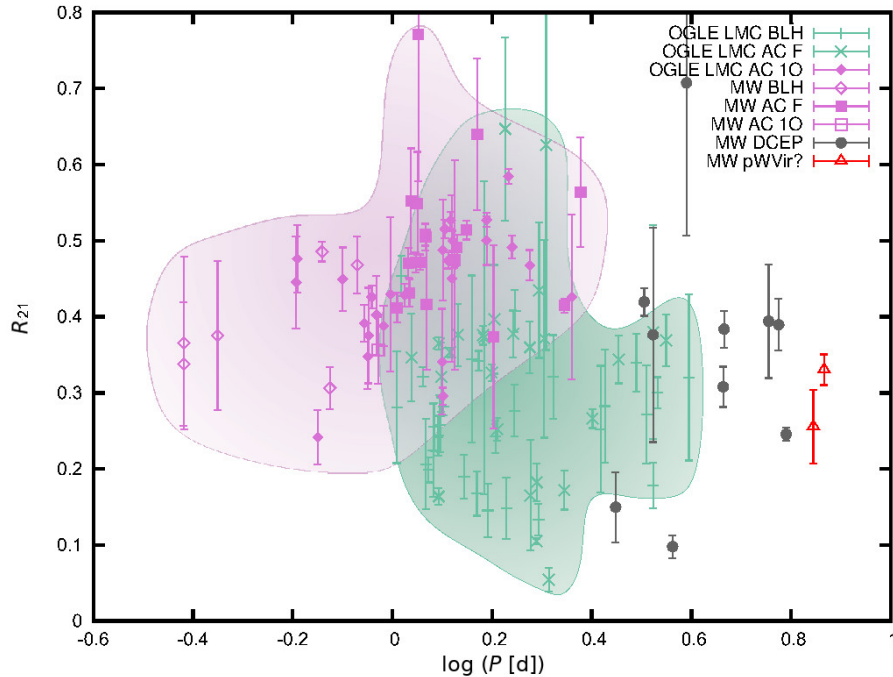


Jurkovic, "Anomalous Cepheids Discovered in a Sample of Galactic Short Period Type II Cepheids", 2018, SAJ, **197**, 13

Klasifikacija

Log P vs. R_{21}

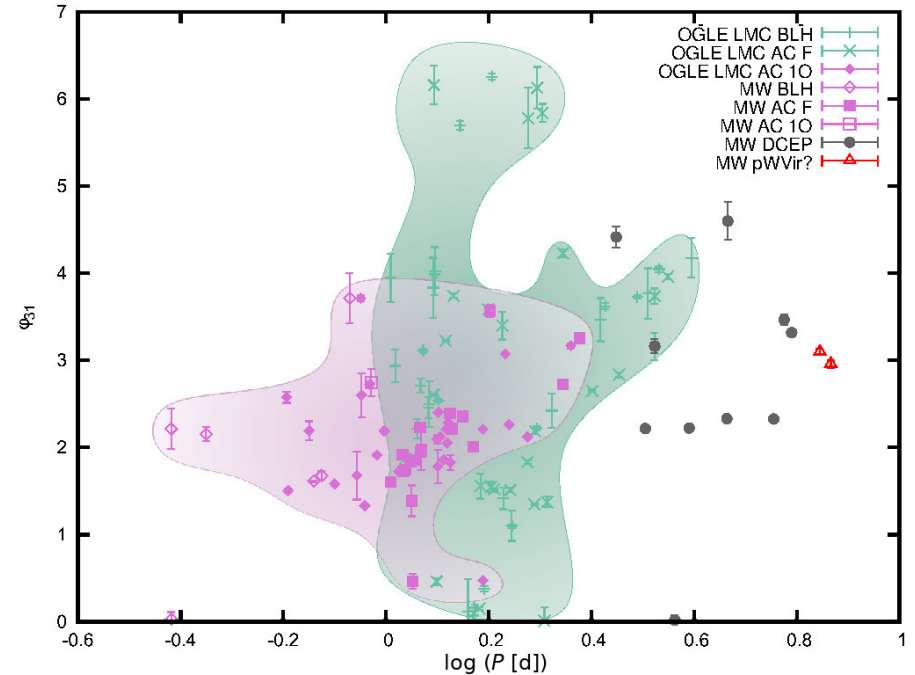
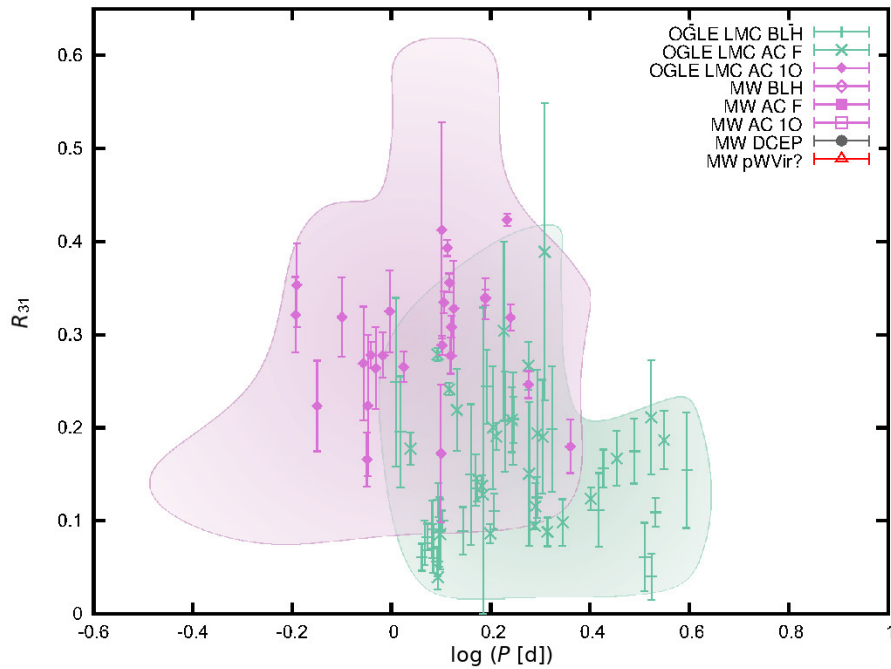
log P vs. ϕ_{21}



Jurkovic, "Anomalous Cepheids Discovered in a Sample of Galactic Short Period Type II Cepheids", 2018, SAJ, **197**, 13

Log P vs. R_{31}

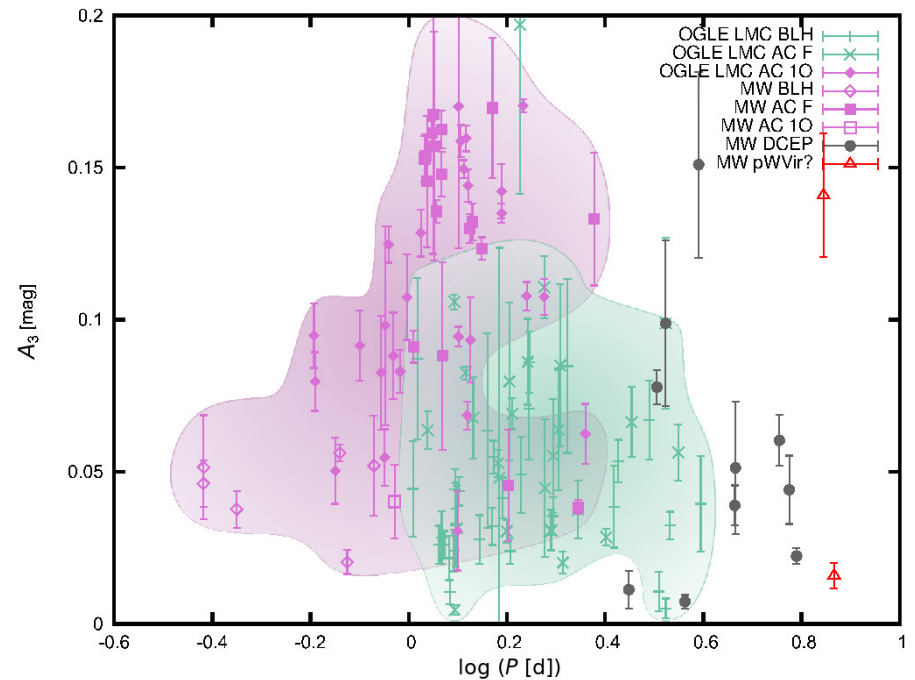
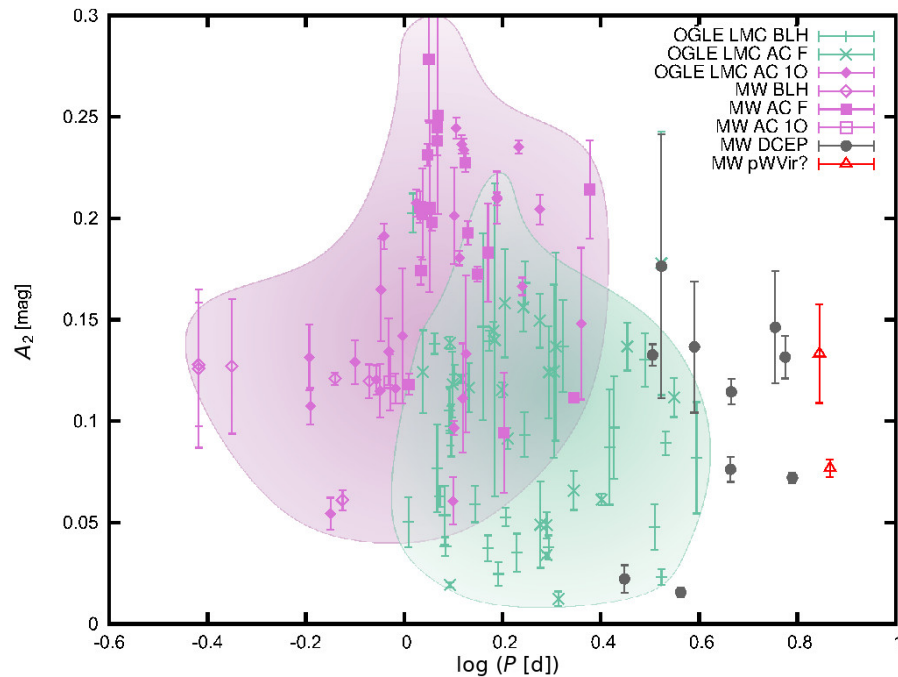
log P vs. ϕ_{31}



Jurkovic, "Anomalous Cepheids Discovered in a Sample of Galactic Short Period Type II Cepheids", 2018, *SAJ*, **197**, 13

Log P vs. A_2

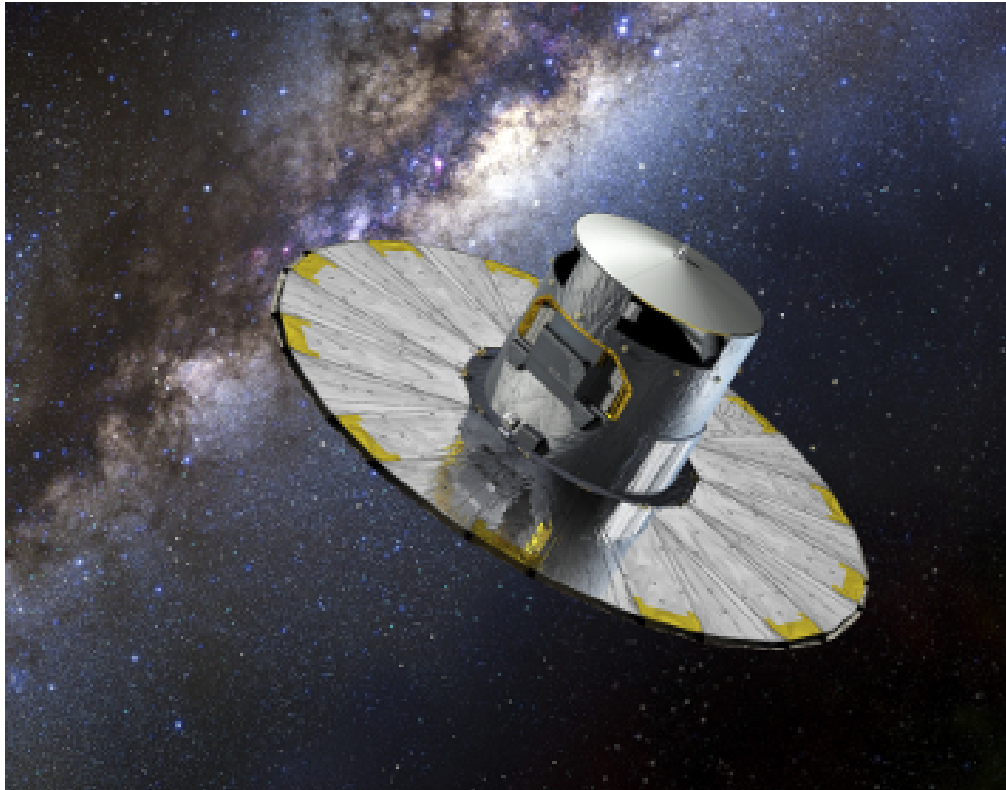
log P vs. A_3

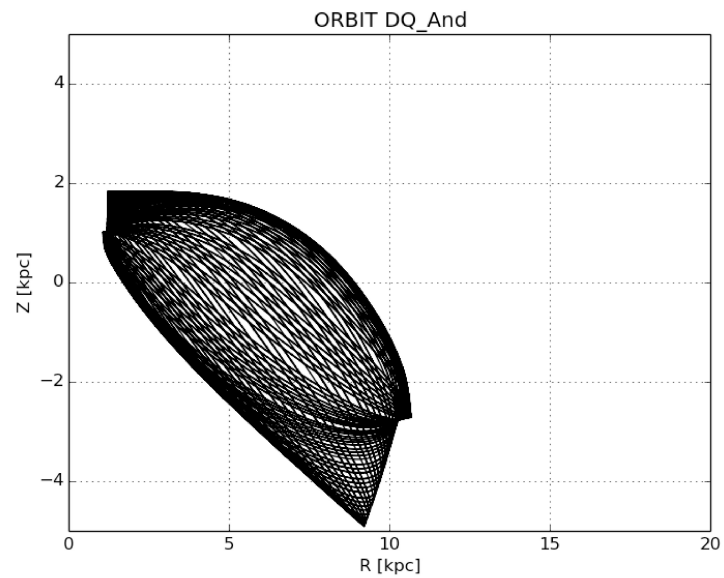
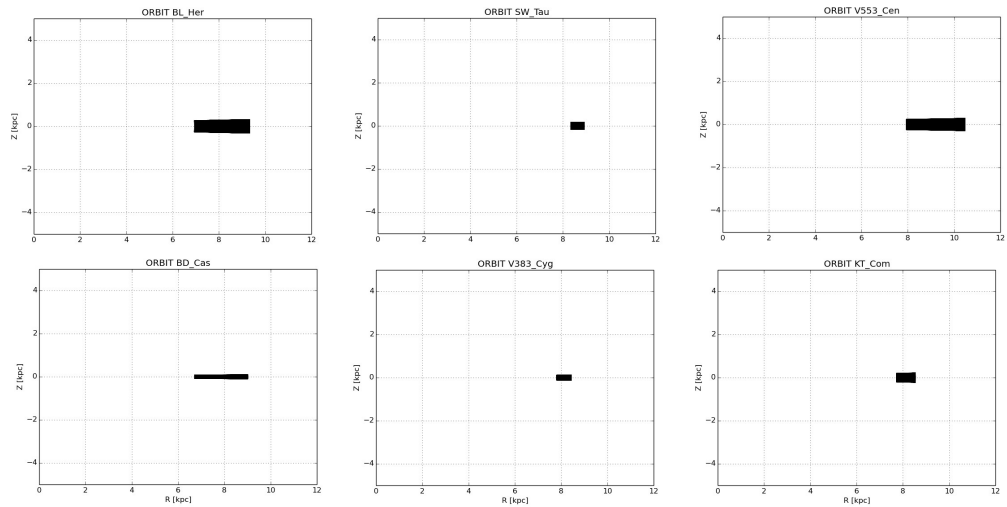
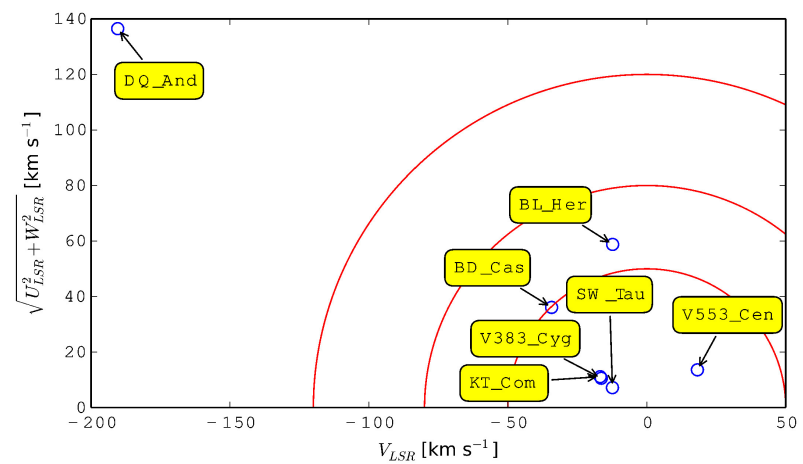


Jurkovic, "Anomalous Cepheids Discovered in a Sample of Galactic Short Period Type II Cepheids", 2018, *SAJ*, **197**, 13

Galaktička pripadnost cefeida tipa II i anomalnih cefeida

Gaia svemirski teleskop

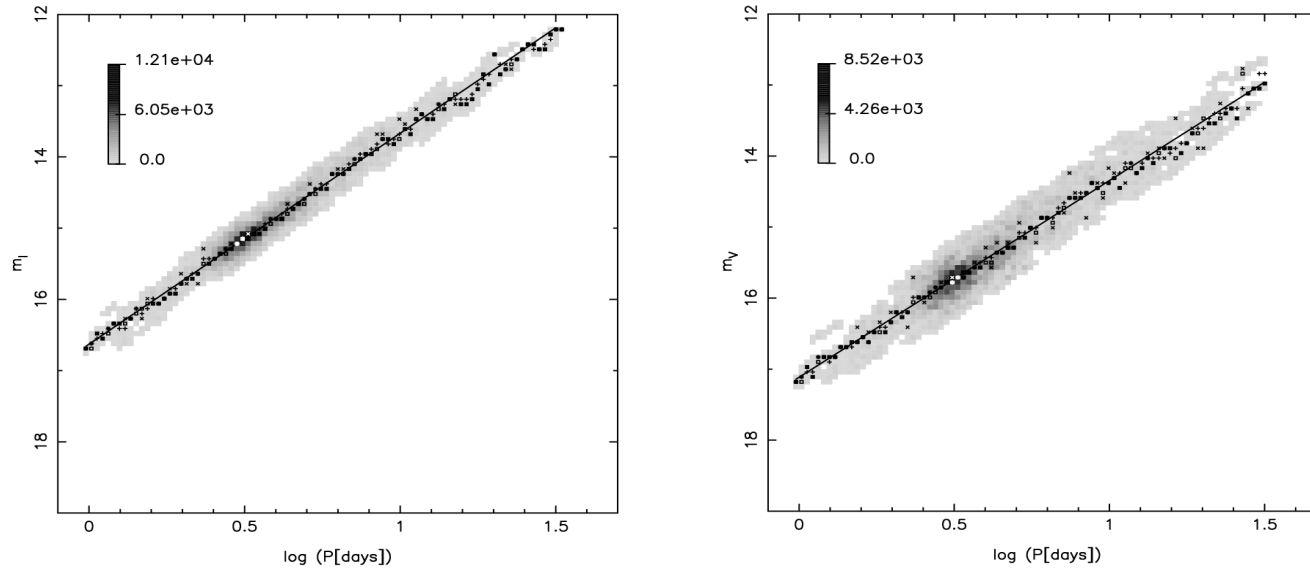




Projekat sa dr Branislavom Vukotićem:

statistika gustine podataka za PL relaciju ili bilo koje druge parametre promenljivih zvezda

Figure 3. Greyscale reconstructed data PDF for an extinction corrected sample of fundamental mode LMC Cepheids from ...





KEEP CALM

AND

THANK YOU

FOR YOUR

ATTENTION