OGLE Survey:

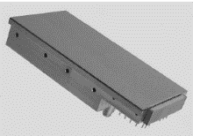
Over Three Decades of time domain astrophysics

Andrzej Udalski

Obserwatorium Astronomiczne
Uniwersytetu Warszawskiego

Time Domain Astrophysics

- Studies of astronomical objects in different time scales
- Technique applied and used by astronomers for many centuries
- New approach and blooming period of TDA starts in 1990s

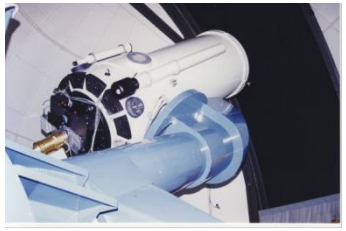


- Bohdan Paczyński: 1980s – long term DM and exoplanets search with microlensing, all sky shallow surveys

- Pioneers of new generation TDA (1990s) – microlensing surveys: OGLE , MACHO, EROS, later MOA. A few years later: all sky or dedicated shallow surveys: ASAS, HAT, WASP
- Examples from 21st century: PTF/ZTF, PanSTARRS, ASAS-SN, KMTNet, LSST, Kepler, TESS, Swift, Gaia, eRossita etc.
- OGLE gradually converted into Large Scale Sky Variability Survey
- OGLE became a mother project for a few widely recognized projects, e.g., CASE, ARAUCARIA. Became a model for KMTNet, a source of excellent data for Gaia and other variability surveys

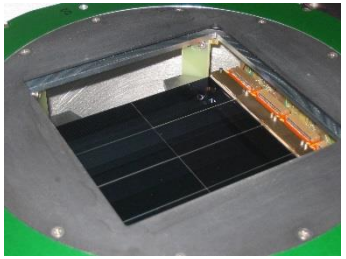
The Optical Gravitational Lensing Experiment (1992 - ….)

Phases of the OGLE Survey:

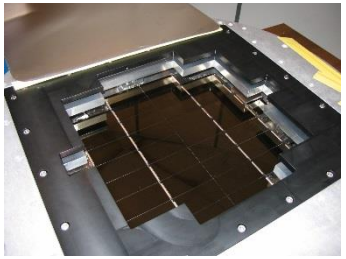


OGLE-I (1992 – 1995). 1 m Swope telescope at Las Campanas Observatory, Chile. ~2 million stars observed. Microlensing

OGLE-II (1997 – 2000). 1.3 m Warsaw telescope. ~40 million stars observed. Variable and non-Variable Stars in GB, MC



OGLE-III (2001– 2009). 8k x 8k mosaic CCD. ~200 million stars observed (GB, GD, MC). Extrasolar Planets, Microlensing



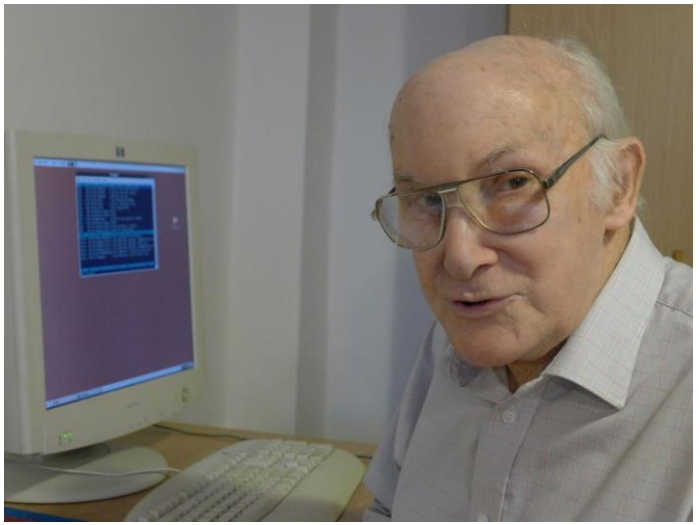
OGLE-IV (2010 – ….). 32-chip 256 Mpixel mosaic CCD. >Two billion stars regularly monitored

(March 17, 2020 – August 12, 2022: CoViD-19 pandemic stopped observations)

http://ogle.astrouw.edu.pl

30th Anniversary

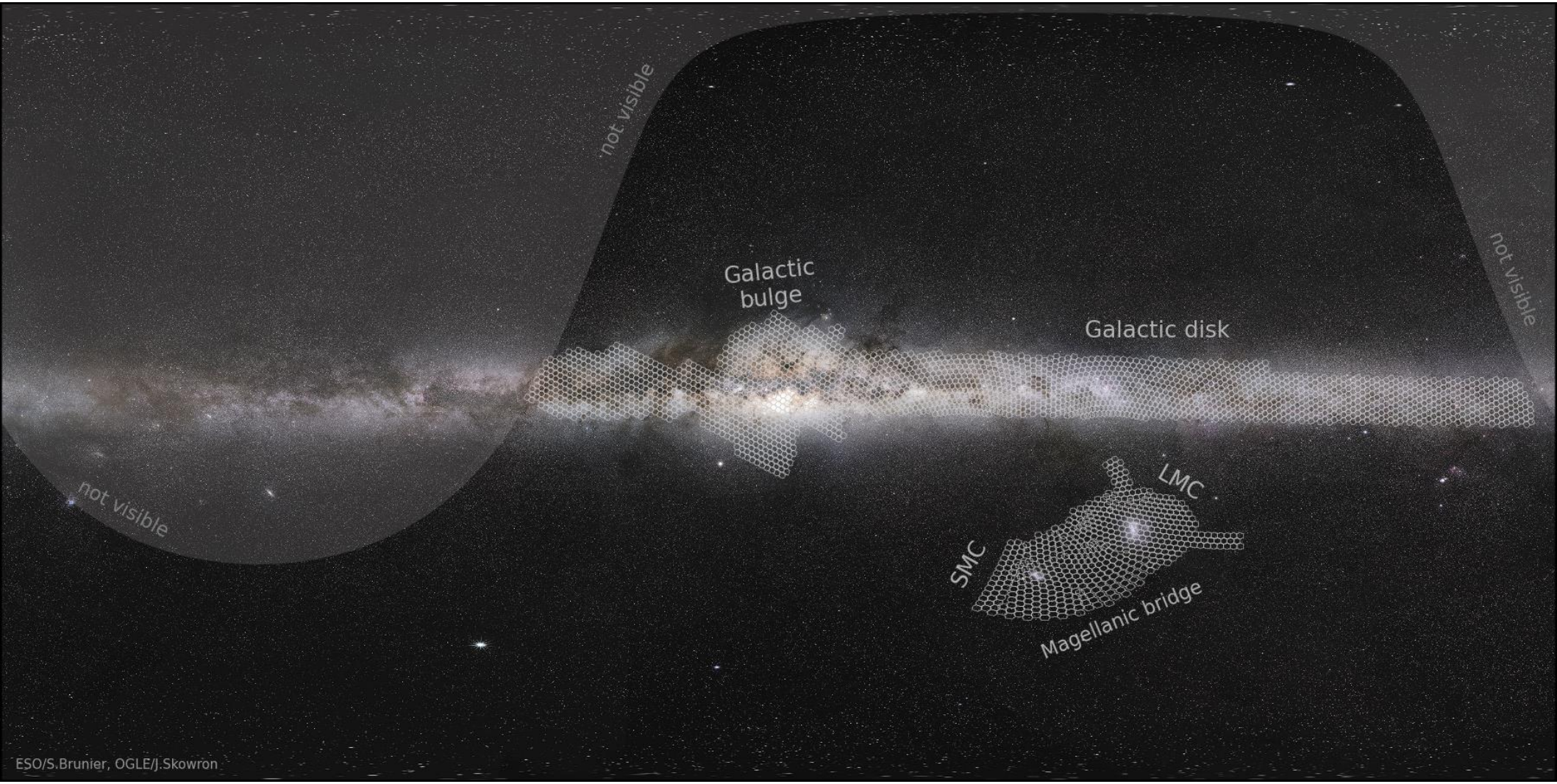
Bohdan Paczyński (1940 – 2007)



Wojtek Krzemiński (1933 – 2017)

Janusz Kałużny (1955 – 2015)

OGLE SKY


not visible
Galactic bulge
Galactic disk
not visible
not visible
LMC
SMC
Magellanic bridge
ESO/S.Brunier, OGLE/J.Skowron

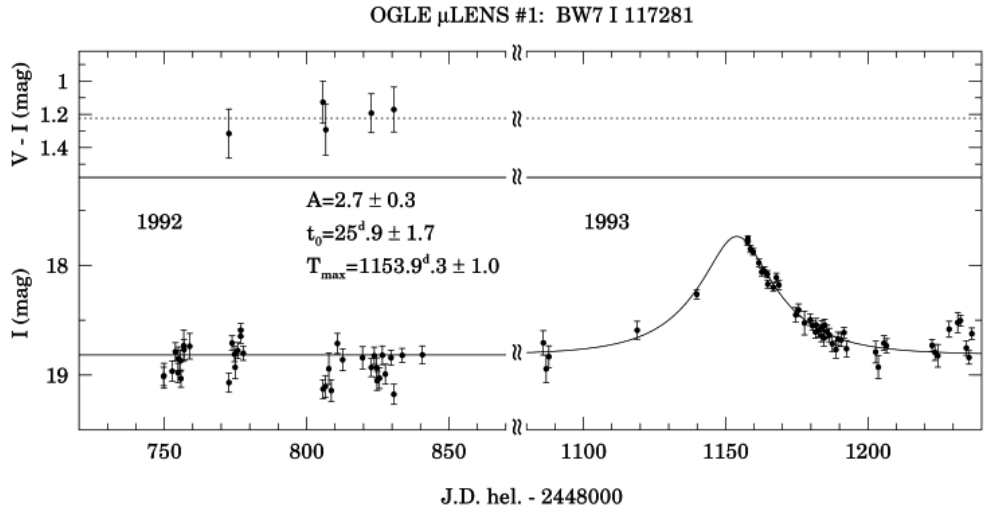
Science Factory

Main Milestones

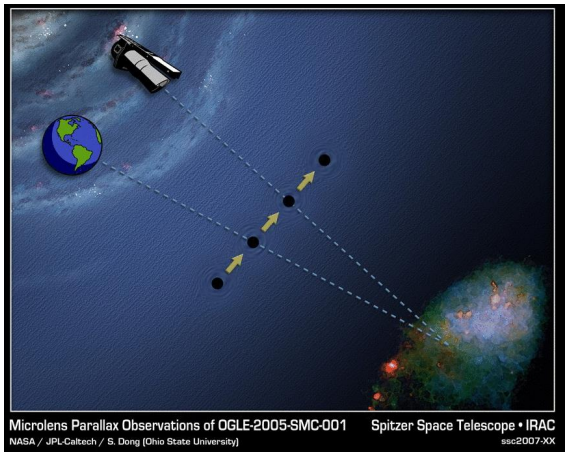
OGLE Microlensing

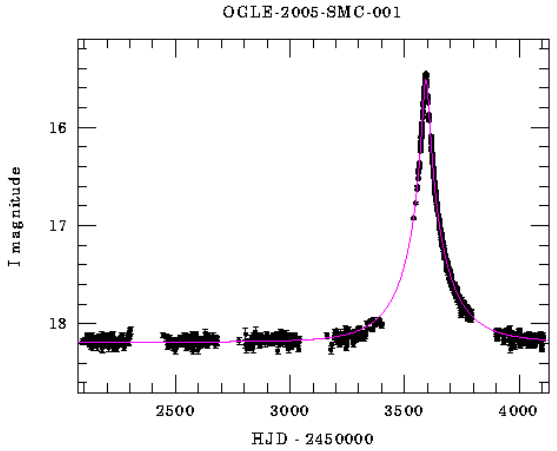
DISCOVERY – 1993

First microlensing event toward the Galactic Center



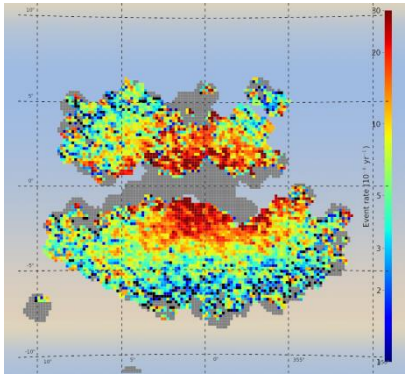
- Search for Dark Matter (1992 – …)



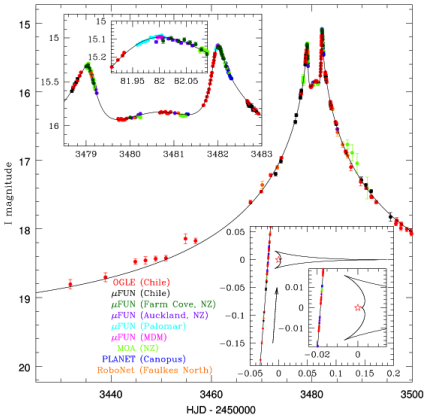


OGLE Microlensing

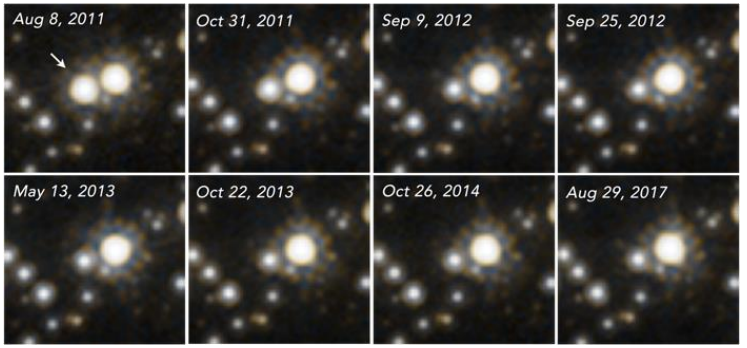
- Galactic Structure Studies (1994 – 2020)

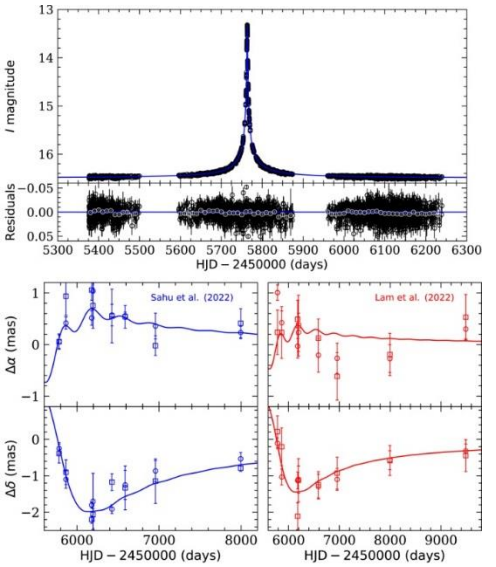


- Microlensing Exoplanets (2004 – …)



- Free Floating Black Holes (2022)

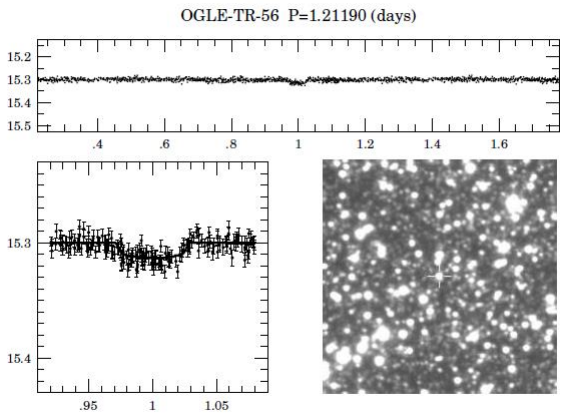


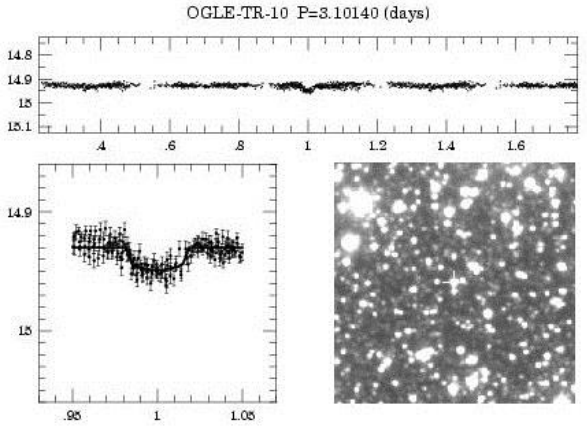


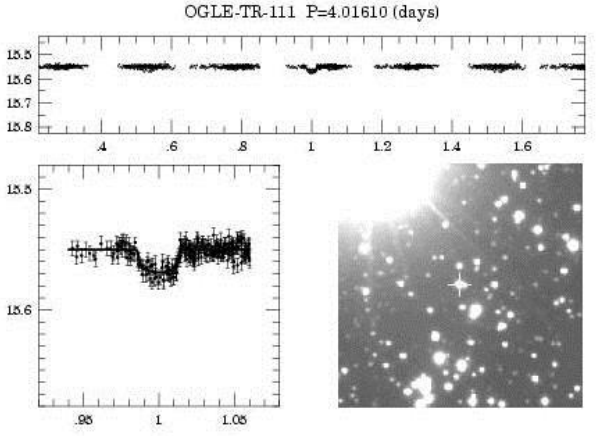
OGLE Exoplanets:
Two New Photometric Methods of Exoplanet Detection

- **Microlensing technique**: First detection of microlensing exoplanets (2004)
- **Transit technique**: First transiting exoplanets detected with classical transit approach

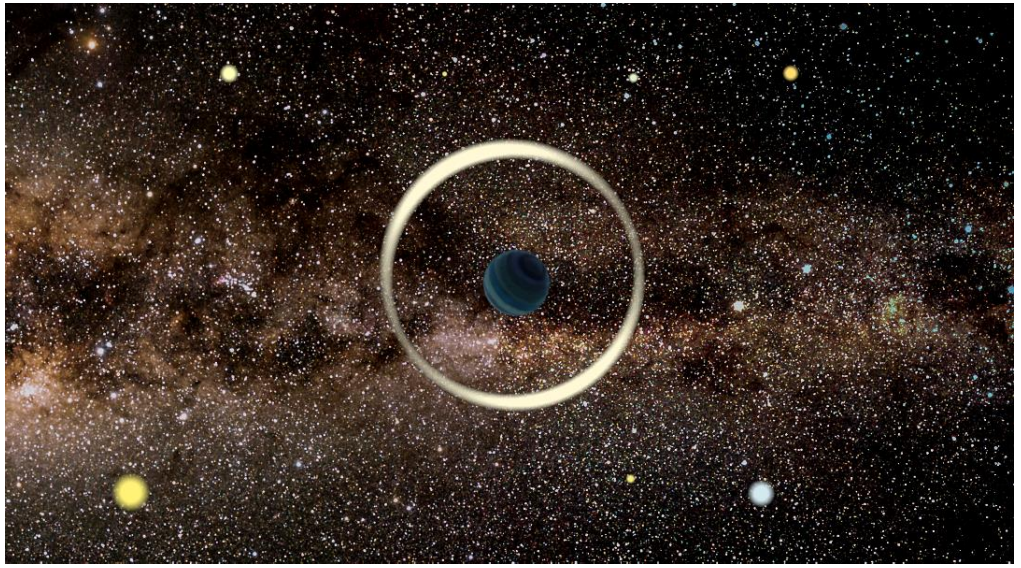
OGLE Transiting Planets (2001 – 2006)

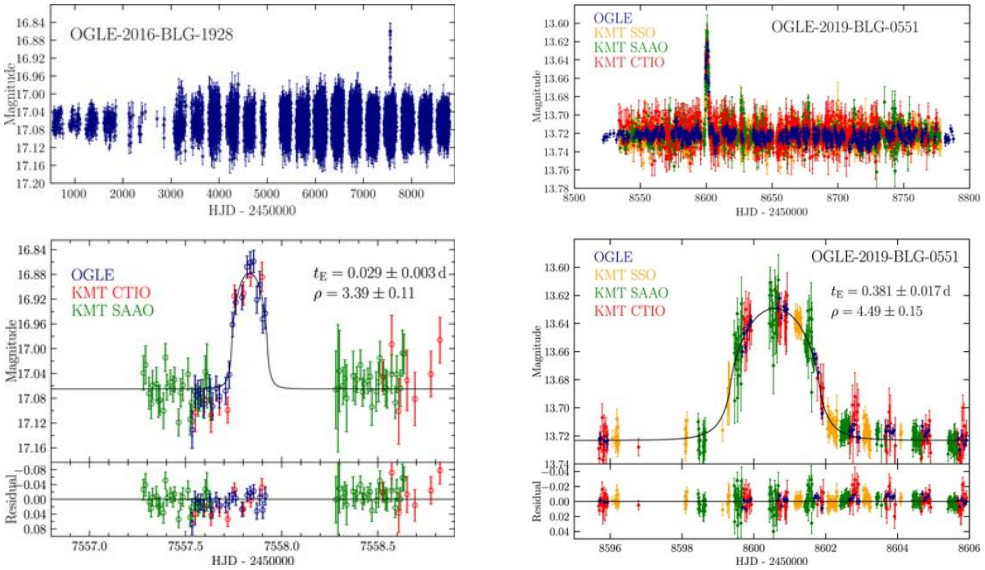






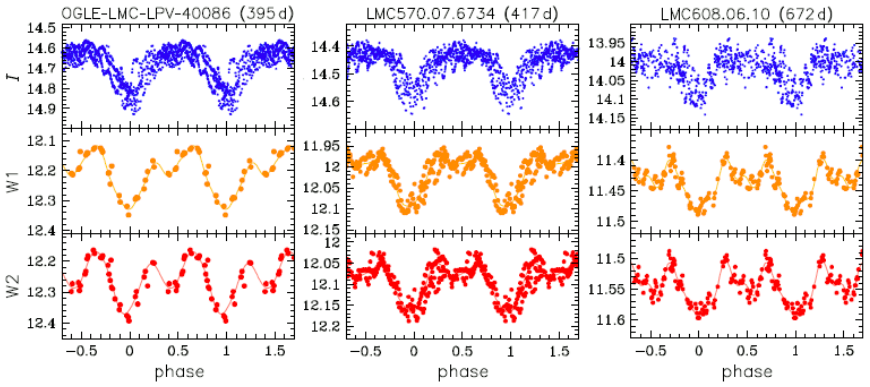
OGLE Free Floating Planets





Series of papers on FFPs – Przemek Mróz *et al*.

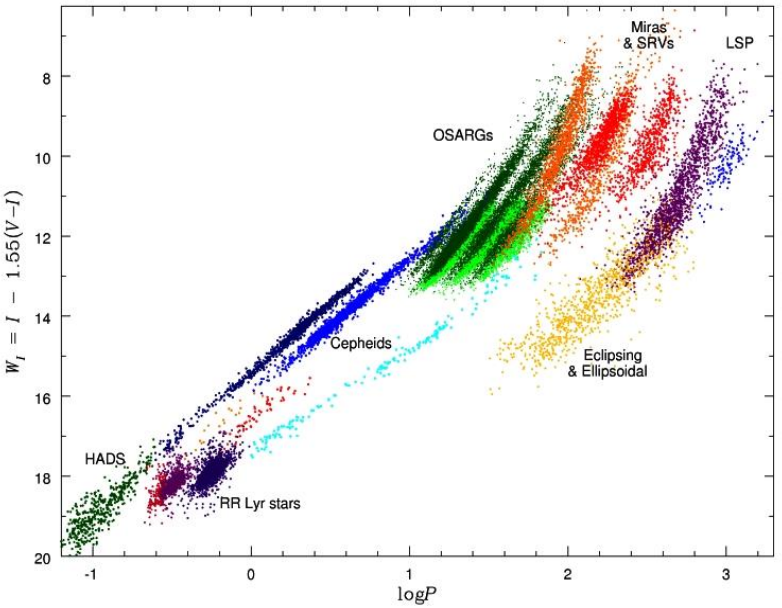
OGLE LSP – Traces of exoplanets?



ERC Starting Grant 2021 – Dorota Skowron

OGLE Collection of Variable Stars

- ~25 years time span, very precise photometry
- High completeness (>90%) and classification purity
- ~>one million OGLE periodic variable stars
- Gold sample of all type variables for other surveys



P – L relations

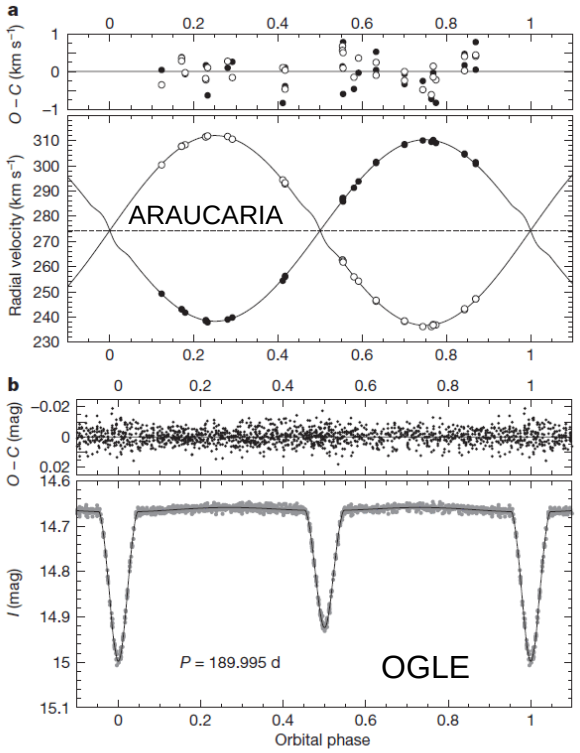


Figure 1 | Change of the brightness of the binary system OGLE-LMC-ECL-06575 and the orbital motion of its components. a, The main panel shows the

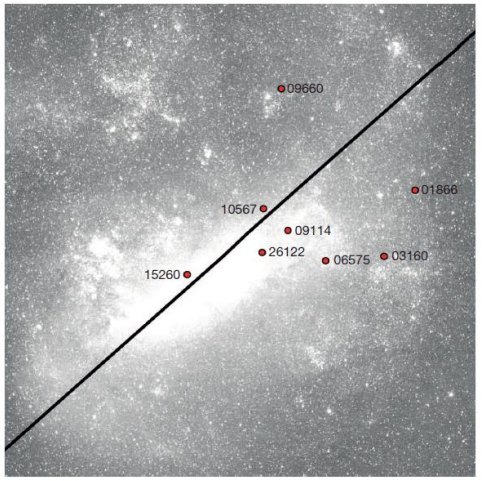
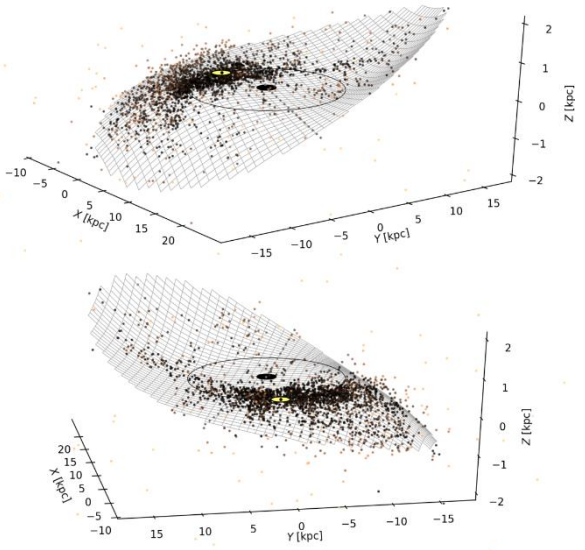


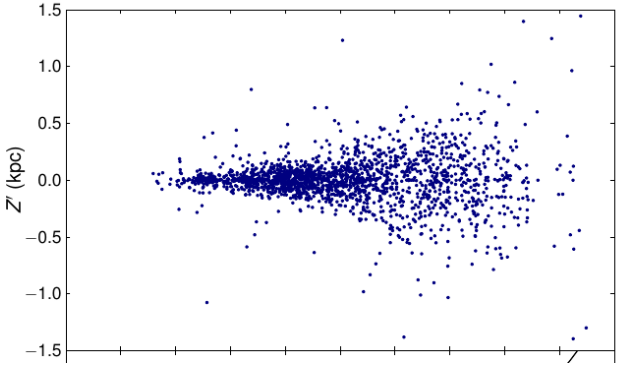
Figure 3 | Location of the observed eclipsing systems in the LMC. Most of

Geometric distance to the LMC

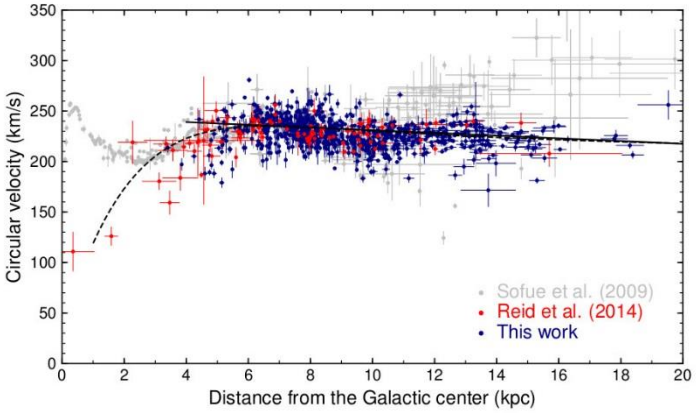
Milky Way and MCs Structure



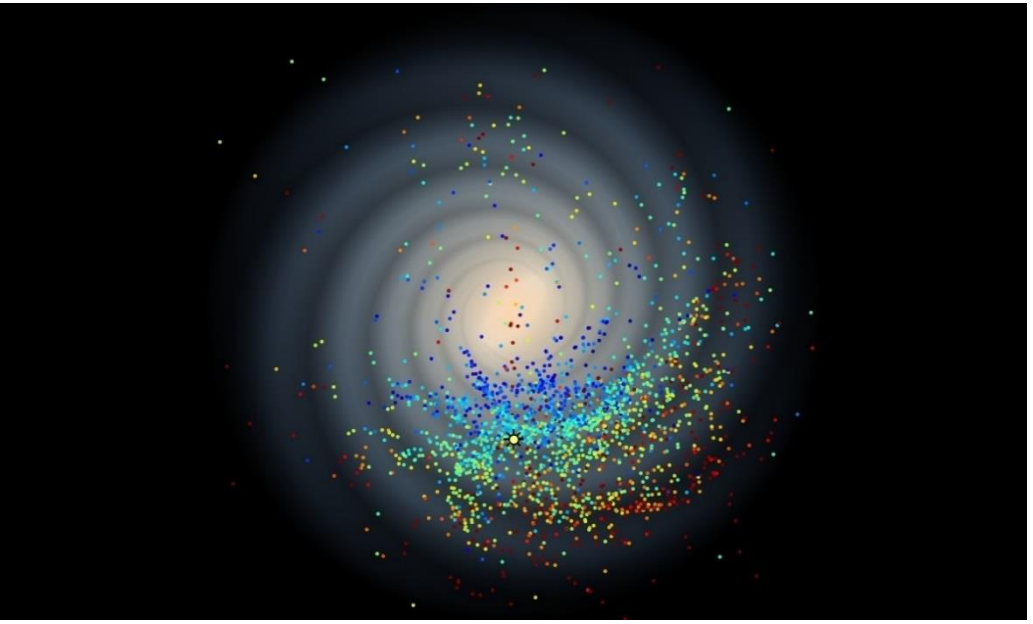
Galactic disk warp



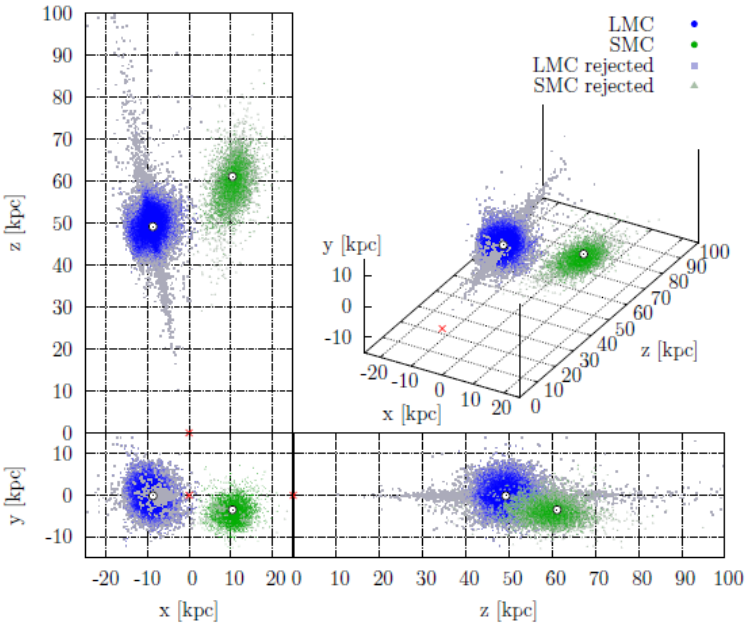
Galactic disk flaring



Galactic rotation curve



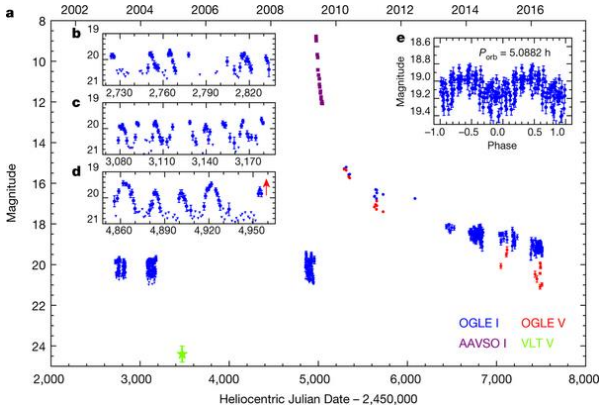
Milky Way top view and age tomography

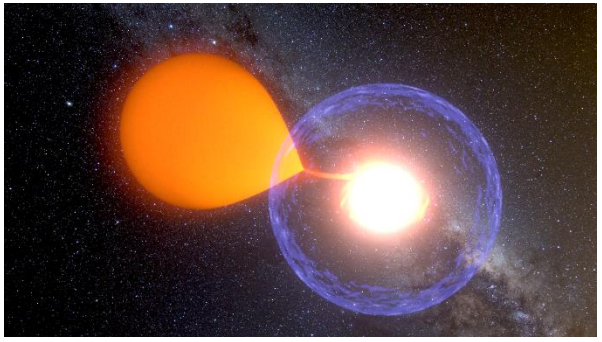


Magellanic Clouds 3D structure

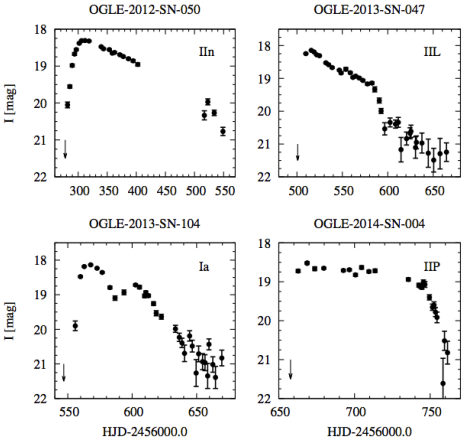
OGLE Transients

- ~2000 Microlensing Events / Season
- ~150 Novae
- > 1000 Dwarf Novae
- >1000 SNe

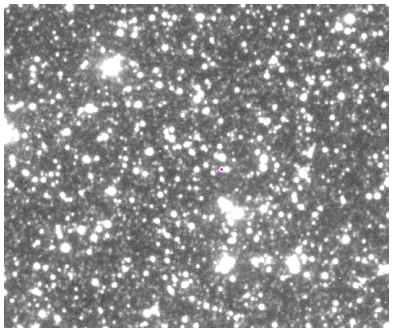


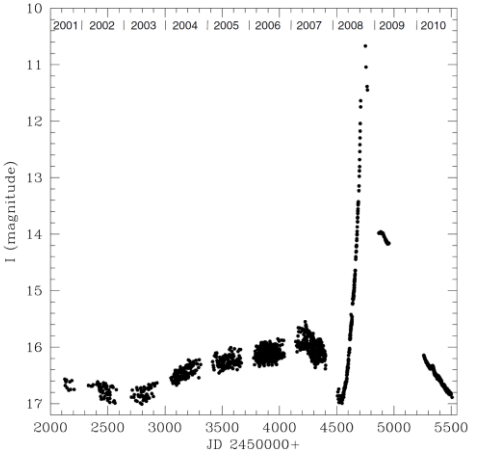


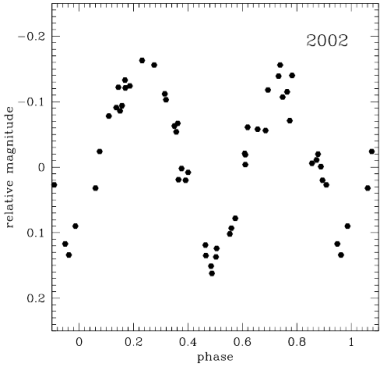
Novae (Nova Centauri 2009)

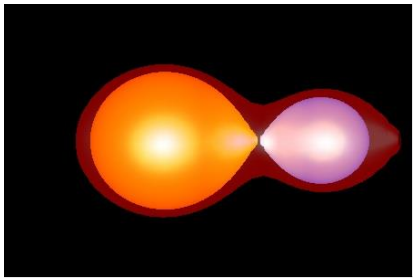


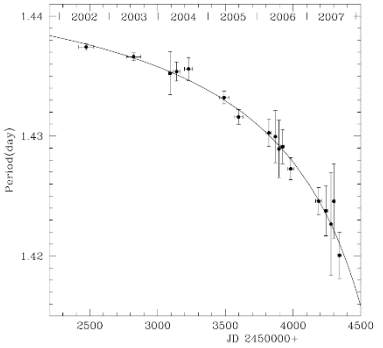
SNe

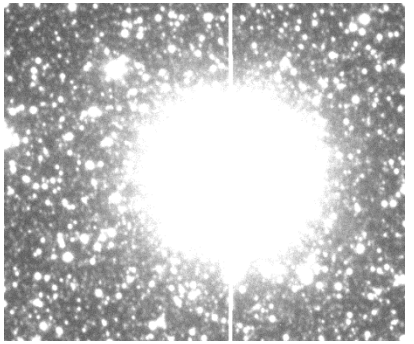










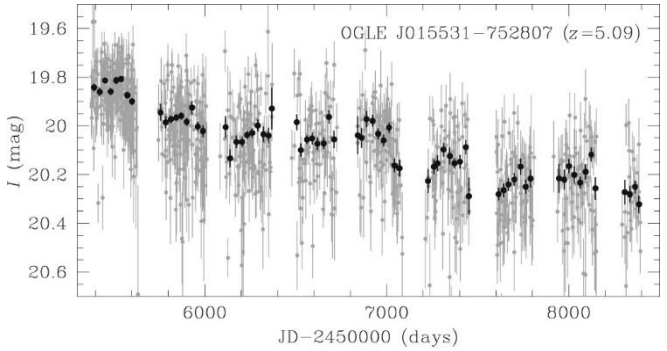


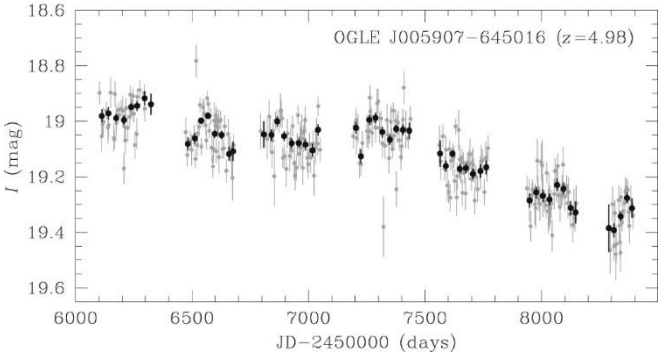
V1309 Sco Red Nova – the first well documented stellar merger

Covering the Whole Universe:

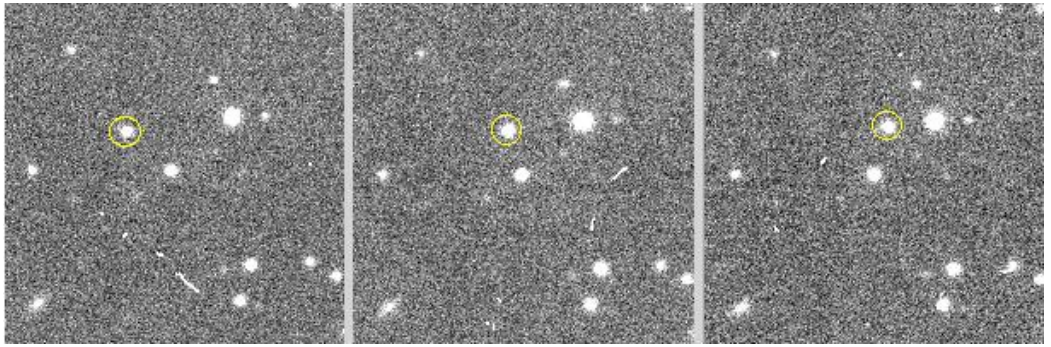
OGLE

z ~ 5 quasars

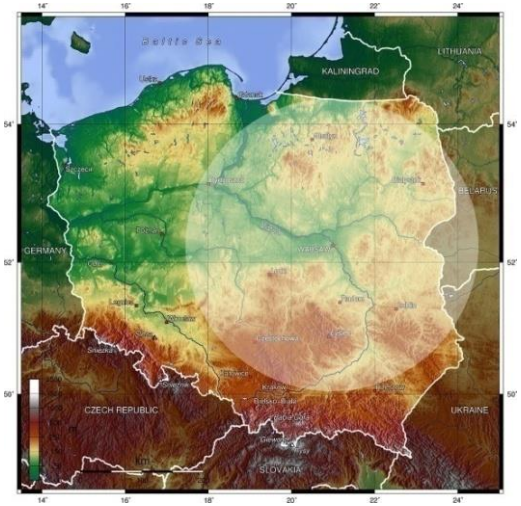




OGLE **Trans Neptunian Objects**



April 15, 2018



D ~ 500 km
(*Herschel*)

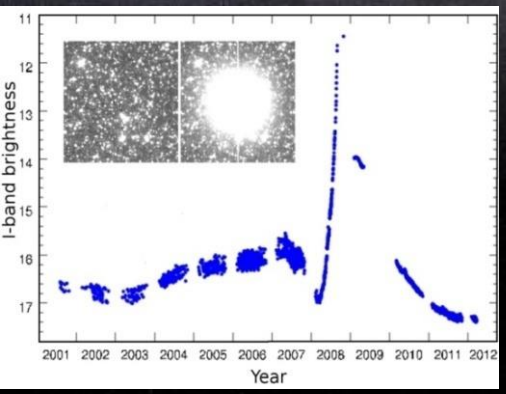
DZIEWANNA (2010 EK 139)

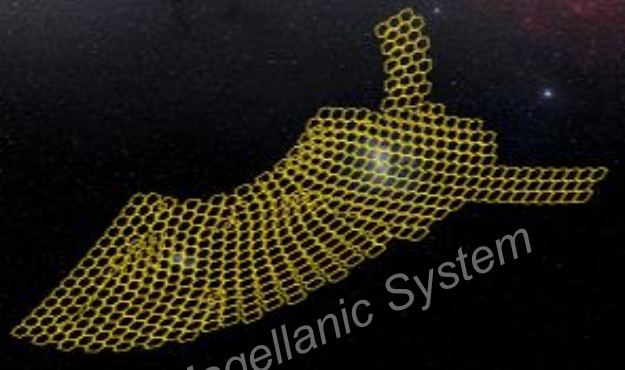
Slavic Goddess of the wild nature

OGLE – an Extremely Large Sky Variability Survey

Warsaw 1.3-m @ Las Campanas

- in operation since 1992
- since 2010 as OGLE-IV (Udalski *et al.* 2015)
- > 4000 deg² sky coverage
- > 2.3 billion sources monitored
- 10^{12} photometric measurements by 2016
- > 22,000 microlensing detections
- > 100 extrasolar planets
- > 1,000,000 new variable periodic stars





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