



МГУ, ГАИШ,

Лаборатория космического мониторинга

*МАССОВЫЕ ОТКРЫТИЯ КОСМИЧЕСКИХ ВЗРЫВОВ
ТЕЛЕСКОПАМИ-РОБОТАМИ МАСТЕР*



Проф. В.М.Липунов

MASTER –

Mobile Astronomical System of the TElescope- Robots

Last Year
CONFERENCES

GAIA, Bologna, Oct 2012

Multiwave Transients, Leiden,
May, 2013

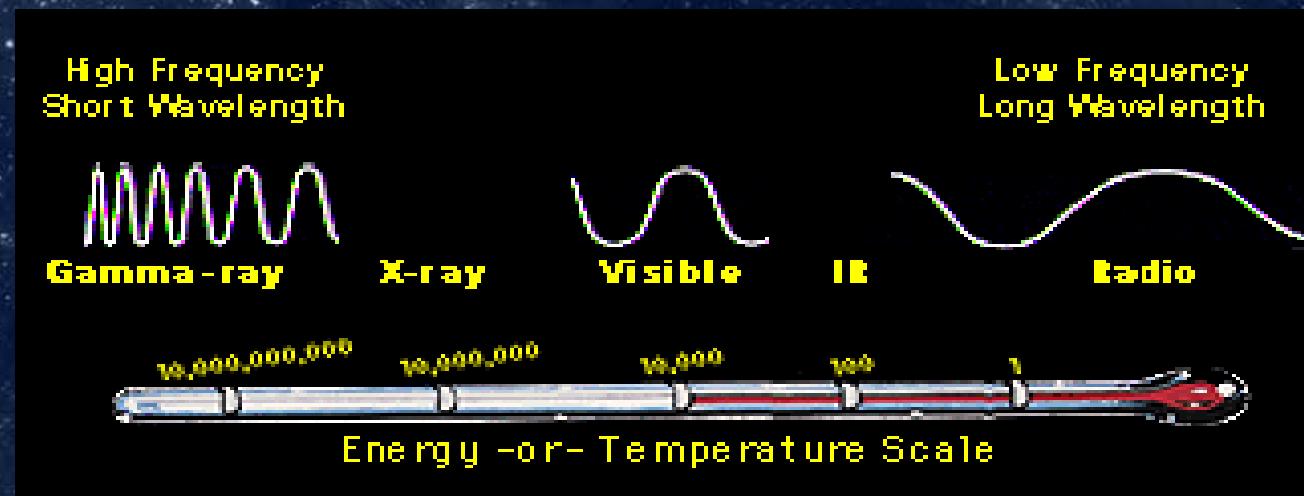
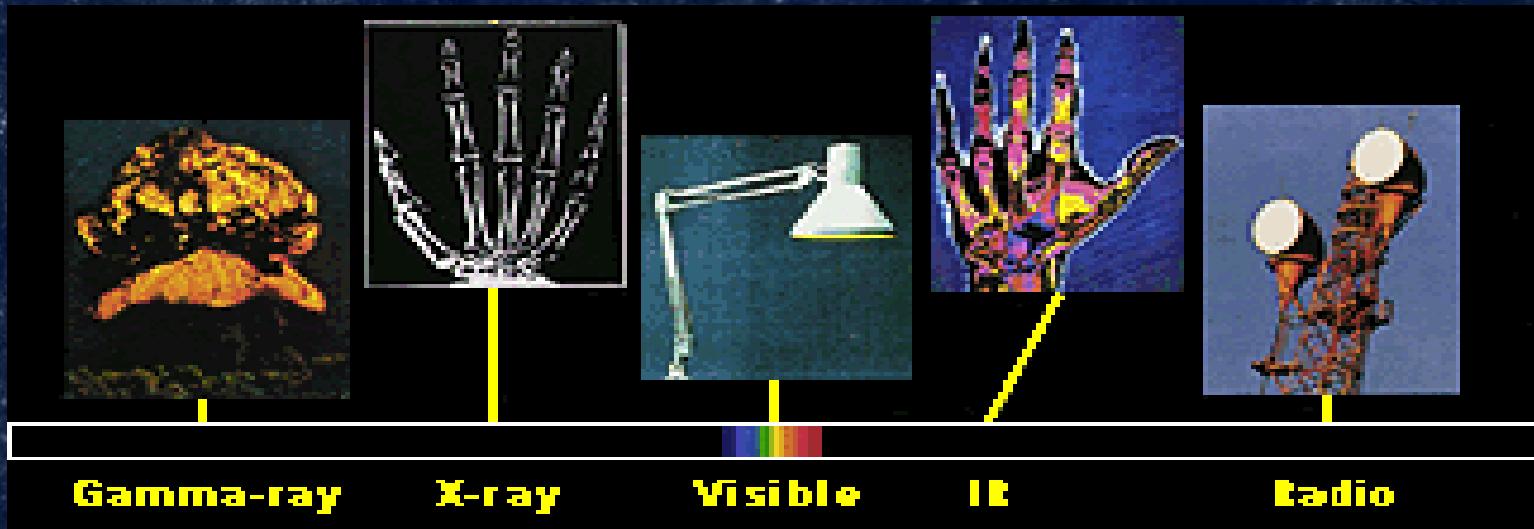
LIGO, Amsterdam, Aug, 2013

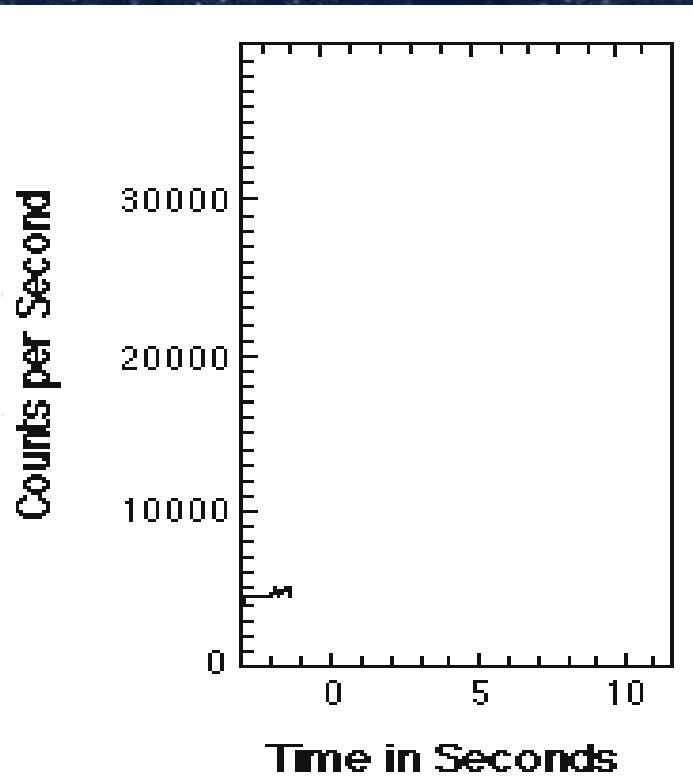
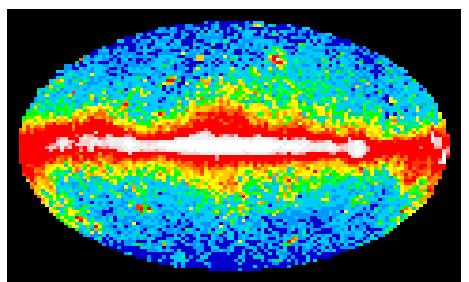
LSST, Cambridge, Sept, 2013

Robotic Observatories, Malaga,
Oct, 2013



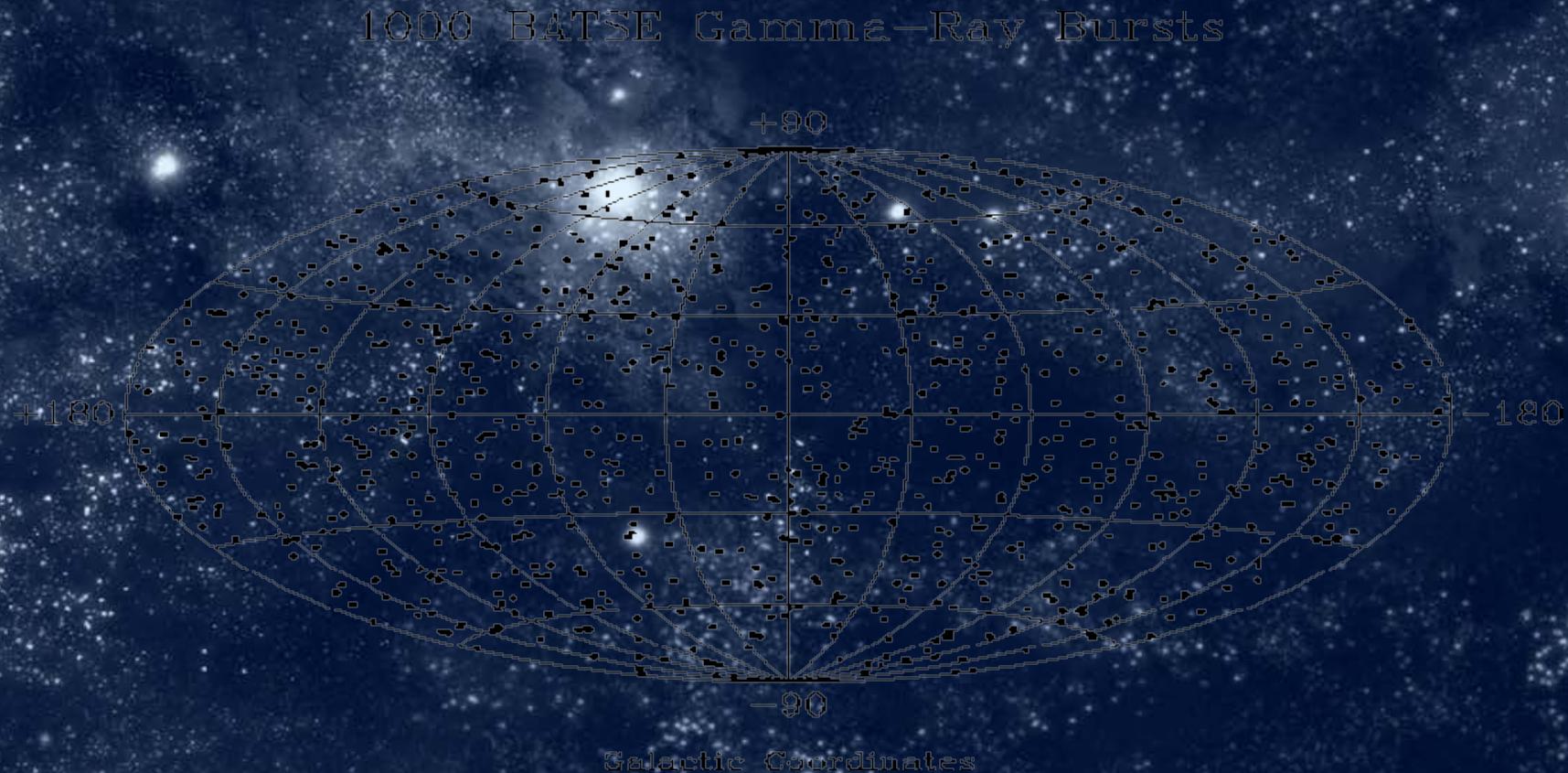
What is the nature of Gamma-rays?





Isotropy

Mazets et al., 1979

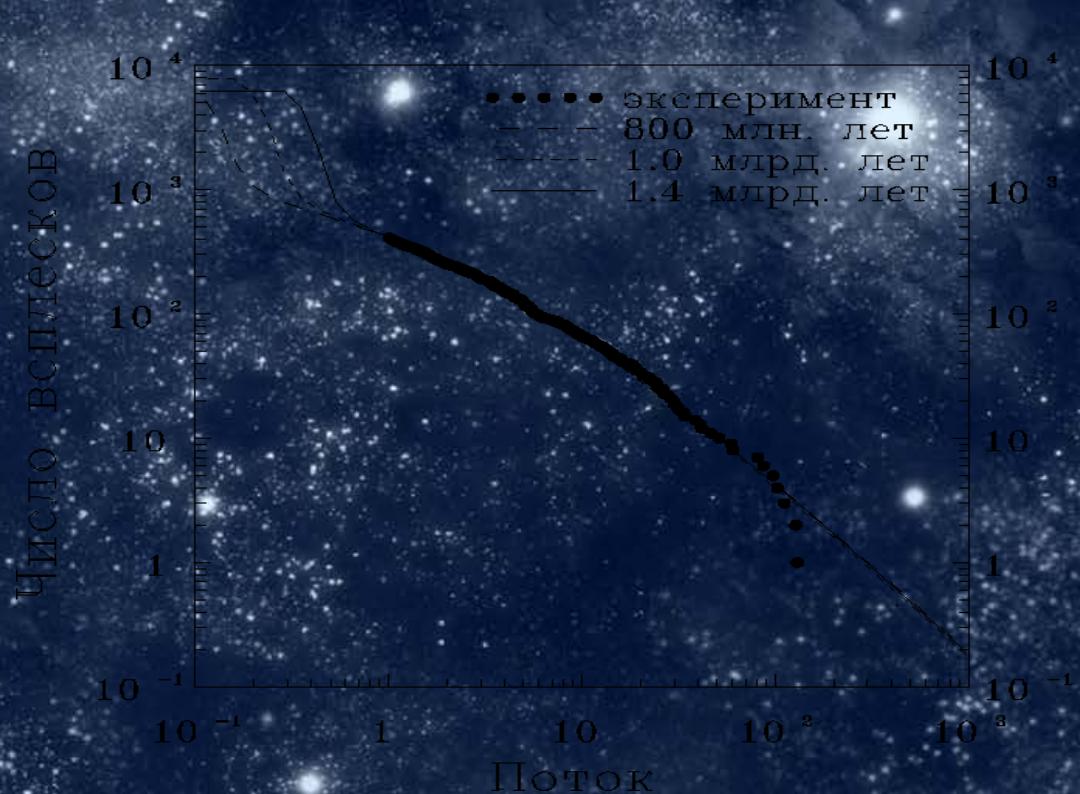


SPACE DISTRIBUTION:

Mazetz et al., . 1980s

Evolution of the Double Neutron Star Merging Rate and the Cosmological Origin of Gamma-Ray Burst Sources

Lipunov et al., 1995, Astrophysical Journal v.454, p.593



$$F = \frac{L}{4\pi R^2},$$

$$N(> F) \sim \frac{4}{3}\pi R^3 \sim F^{-3/2}.$$

$$\log N \sim -\frac{3}{2} \log F.$$

EVOLUTION OF THE DOUBLE NEUTRON STAR MERGING RATE AND THE COSMOLOGICAL ORIGIN OF GAMMA-RAY BURST SOURCES

V. M. LIPUNOV,^{1,2} K. A. POSTNOV,^{1,2} M. E. PROKHOROV,² AND I. E. PANCHENKO¹

Ap.J. 1995, 454, 593

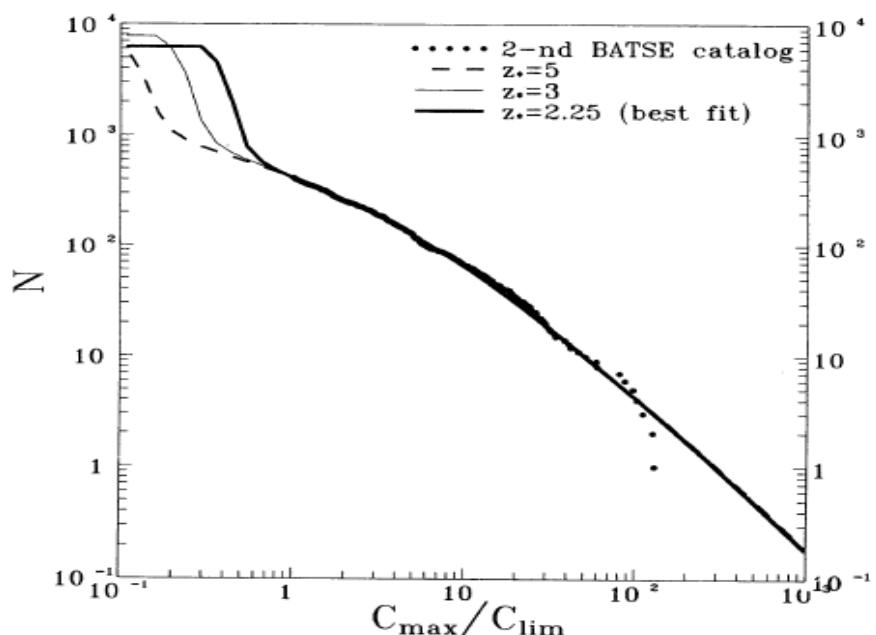


FIG. 3.—A log N -log S diagram simulated for sources evolving as shown in Fig. 1 in a flat cosmological model with the best-fit vacuum energy $\Omega_\Lambda = 0.75$ and parameter $\epsilon = 0.5$.

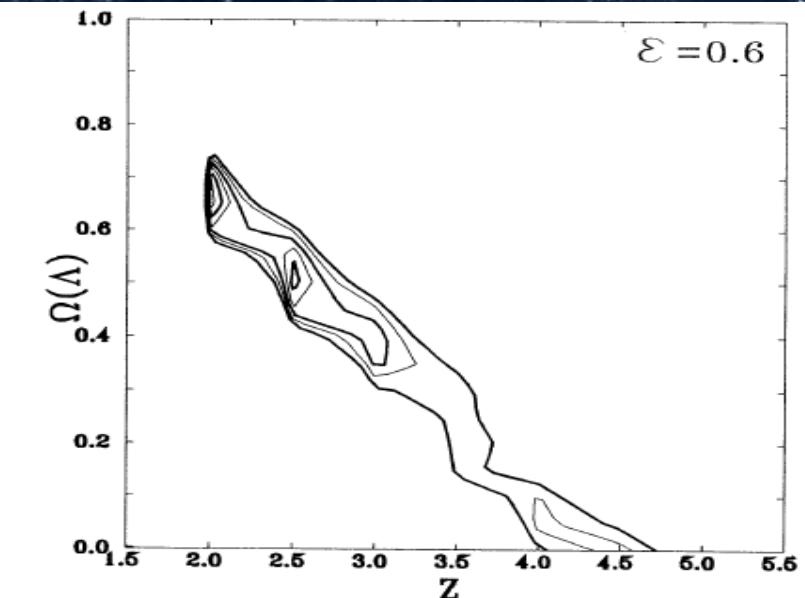


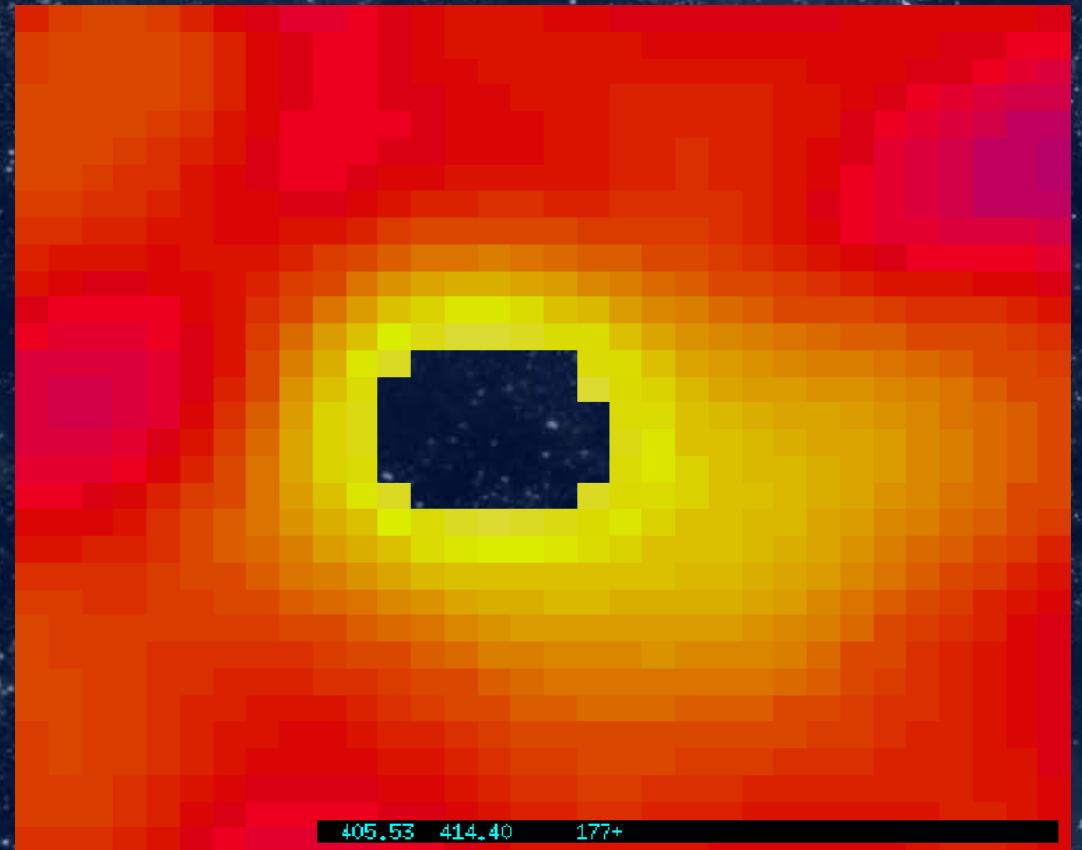
FIG. 2.—Confidence level contour lines (90%, 91%, ...) for the ω^2 test (a) in the $\epsilon-\Omega(\Lambda)$ plane at $z_* = 2.25$, (b) in the $\epsilon-z_*$ plane for $\Omega(\Lambda) = 0.8$, and (c) in the $\Omega(\Lambda)-z_*$ plane for $\epsilon = 0.6$. A flat cosmological model and GRB spectral index $s = 1.5$ with the source evolution as in Fig. 1 are adopted.

Эксперимент BeppoSAX

SAX - аббревиатура итальянского спутника Satelito di Astronomica X

Afterglow GRB970228

Фотография февральского (97 года) гамма-всплеска, снятая с космического телескопа им. Э.Хаббла



1997:
Spectral line discovery

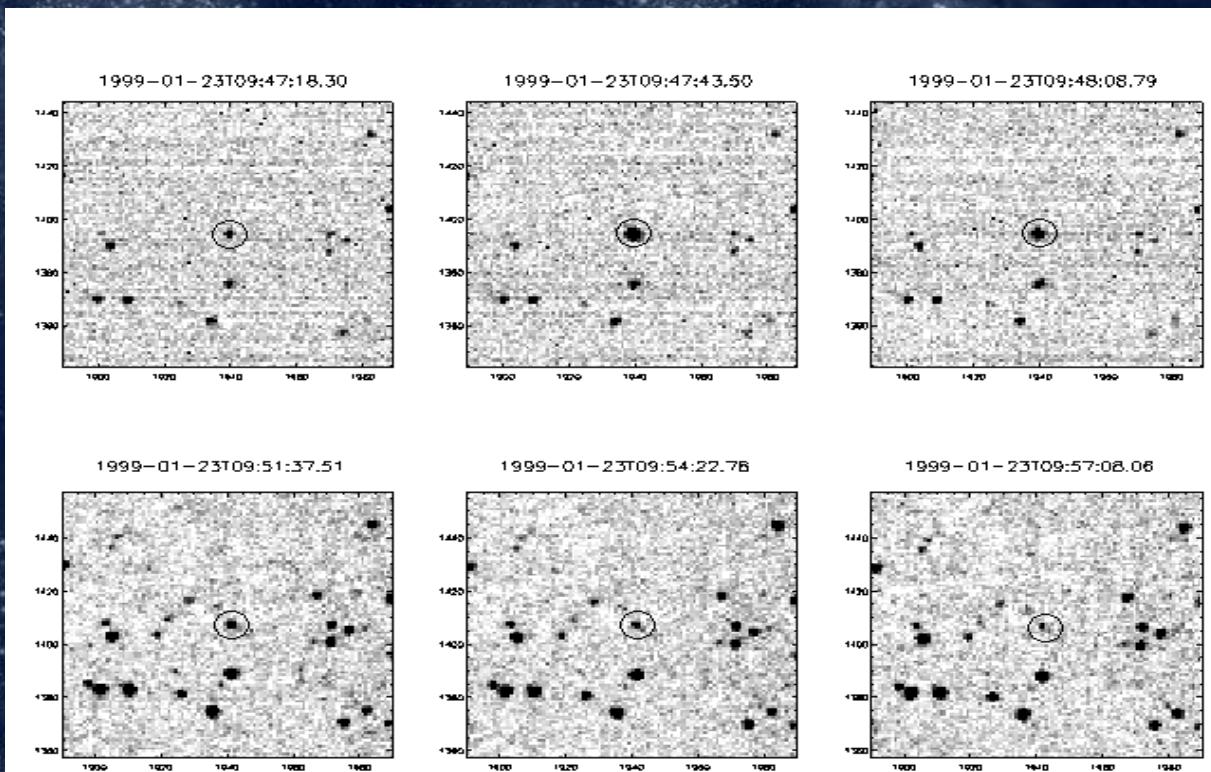
GRB970508

GRBs are cosmological!
**Gamma Ray Burst is most powerfull
explosion in the Universe**

Prompt Optical Very Bright Emission Discovery

GRB 990123

ROTSE I Akerlof et al. 1999



Energy

$$E \sim 10^{51-53} \text{ erg}$$

Typical collapse

$$E \sim 0.1 M c^2, M \sim 1-10 M_{\text{solar}}$$

NS merging (Blinikov et al., 1983)

Collapse (Pachinsky, 1986, Astrophys. J. 308, L43-L46)

Spectrum

$E_{\text{peak}} \sim 1 \text{ Mev}$

Typical collapse temperature

$$T \sim 2m_e C^2 \sim 10^{10} \text{ K} \sim 1 \text{ Mev}$$

DURATION

$$\Delta t_{\text{obs}} \sim 0.1 - 100 \text{ s}$$

Typical collapse time

$$\Delta t \sim R_g/c \sim 10^{-5} \text{ s} \ll \Delta t_{\text{obs}}$$

Solution

Magneto-Rotational Collapse

$$\Delta t \sim I \omega / K$$

Where K – dissipation magnetic force moment

$$\Delta t \sim R^2 / D$$

D ~ Viscosity

SN or GRB?

Rate (SN) / Rate (GRB) ~ 100

GRB as the Core Collapse Massive Star

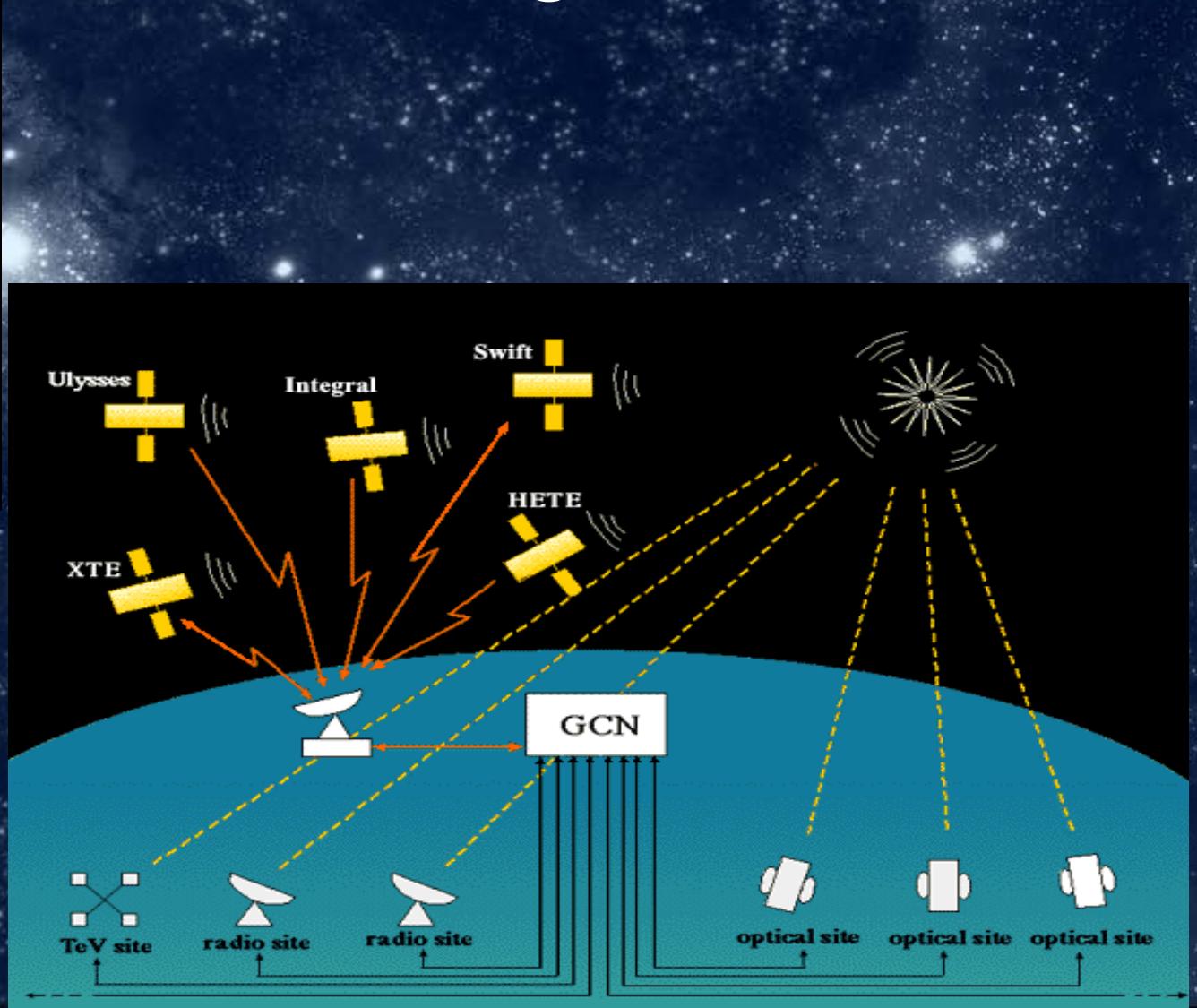
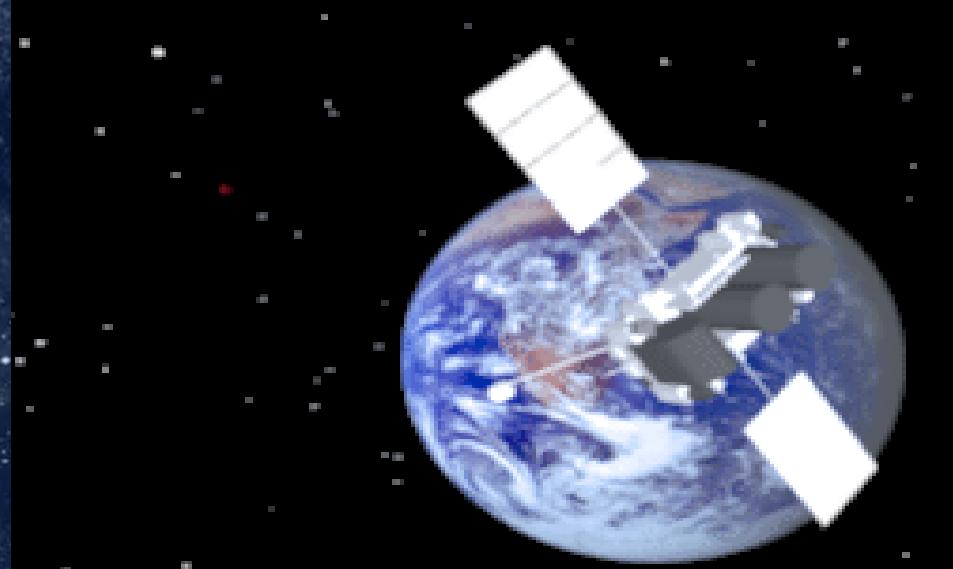


Mechanism

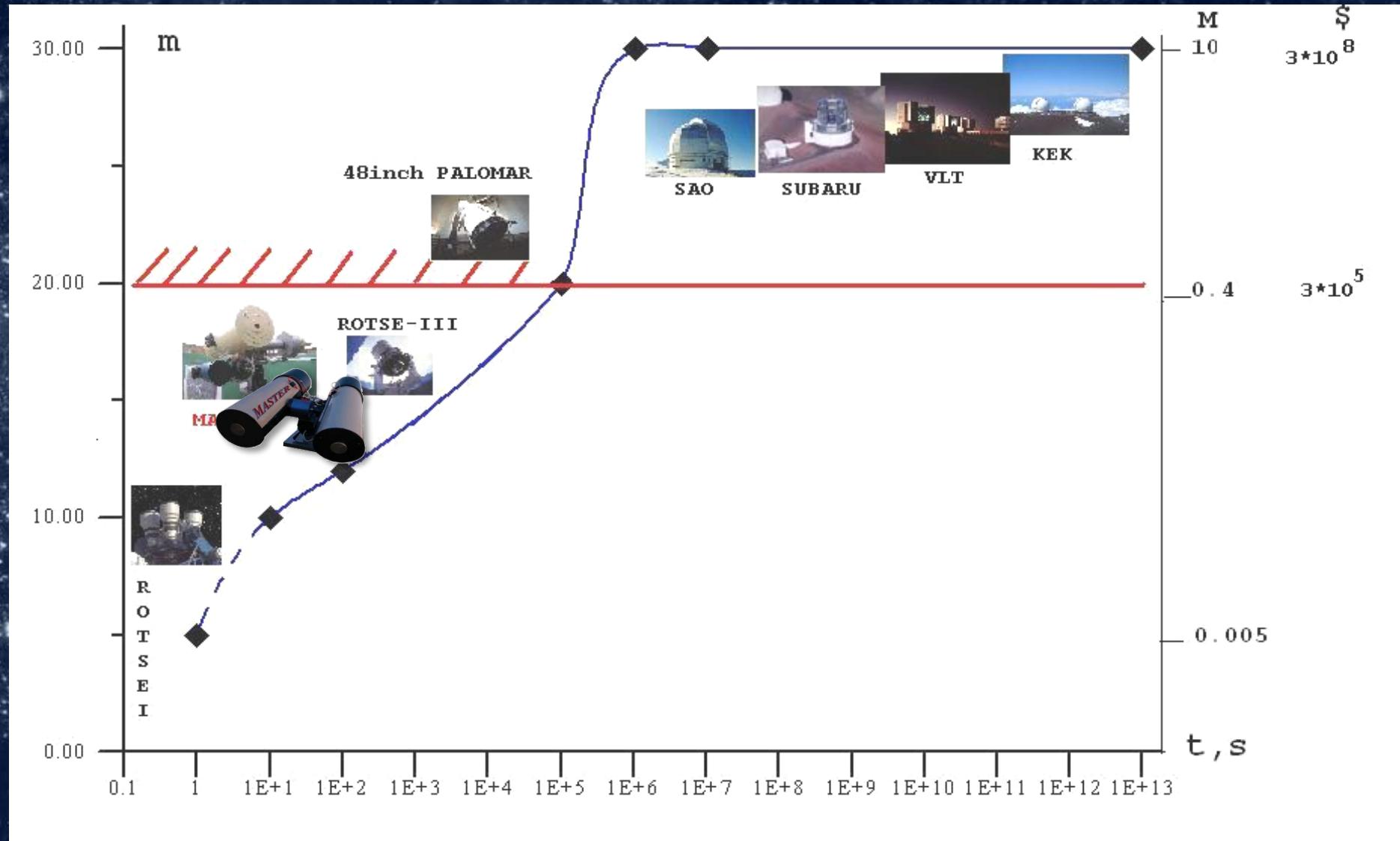
NS-NS merging



GCN global physical experiment: MASTER in Alert regime



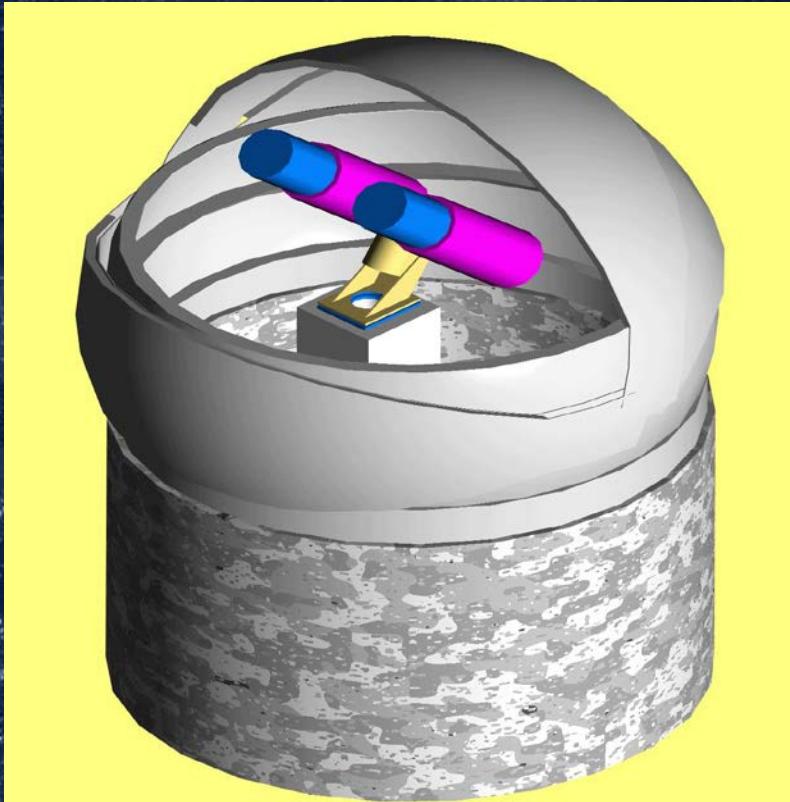
Global MASTER Net 2013 by Vladimir Lipunov at
Gravitational Wave Physics and Astronomy Workshop,
December 17- 20, 2013



Global MASTER Net 2013 by Vladimir
Lipunov at Gravitational Wave Physics and
Astronomy Workshop, December 17-20, 2013

Second Generation Robotic Telescope MASTER II

Wide Field + Color & Polarization



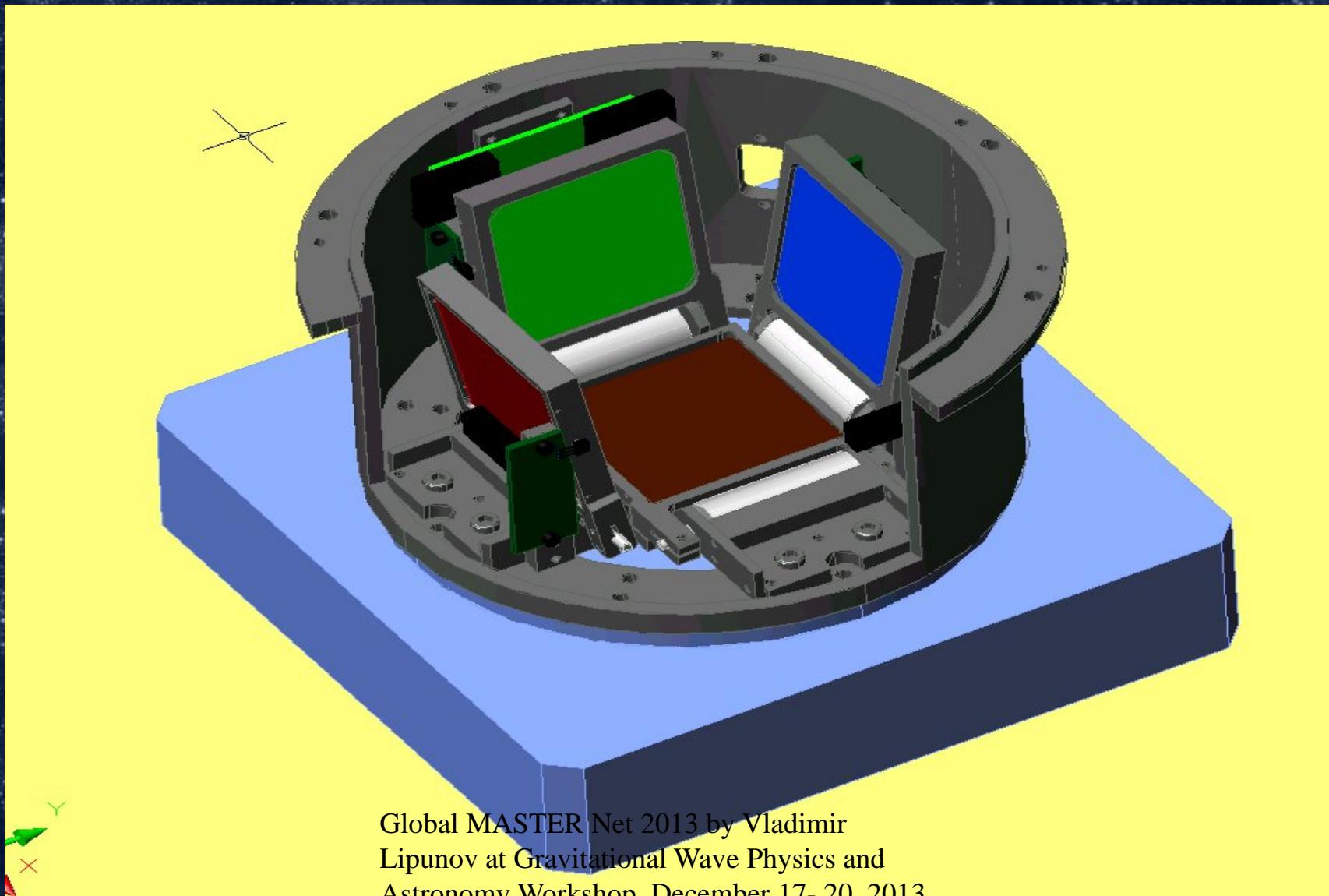
MASTER II (D=400mm)

- FOV= $2 \times 4 = 8$ square degrees up to 20-21 up.



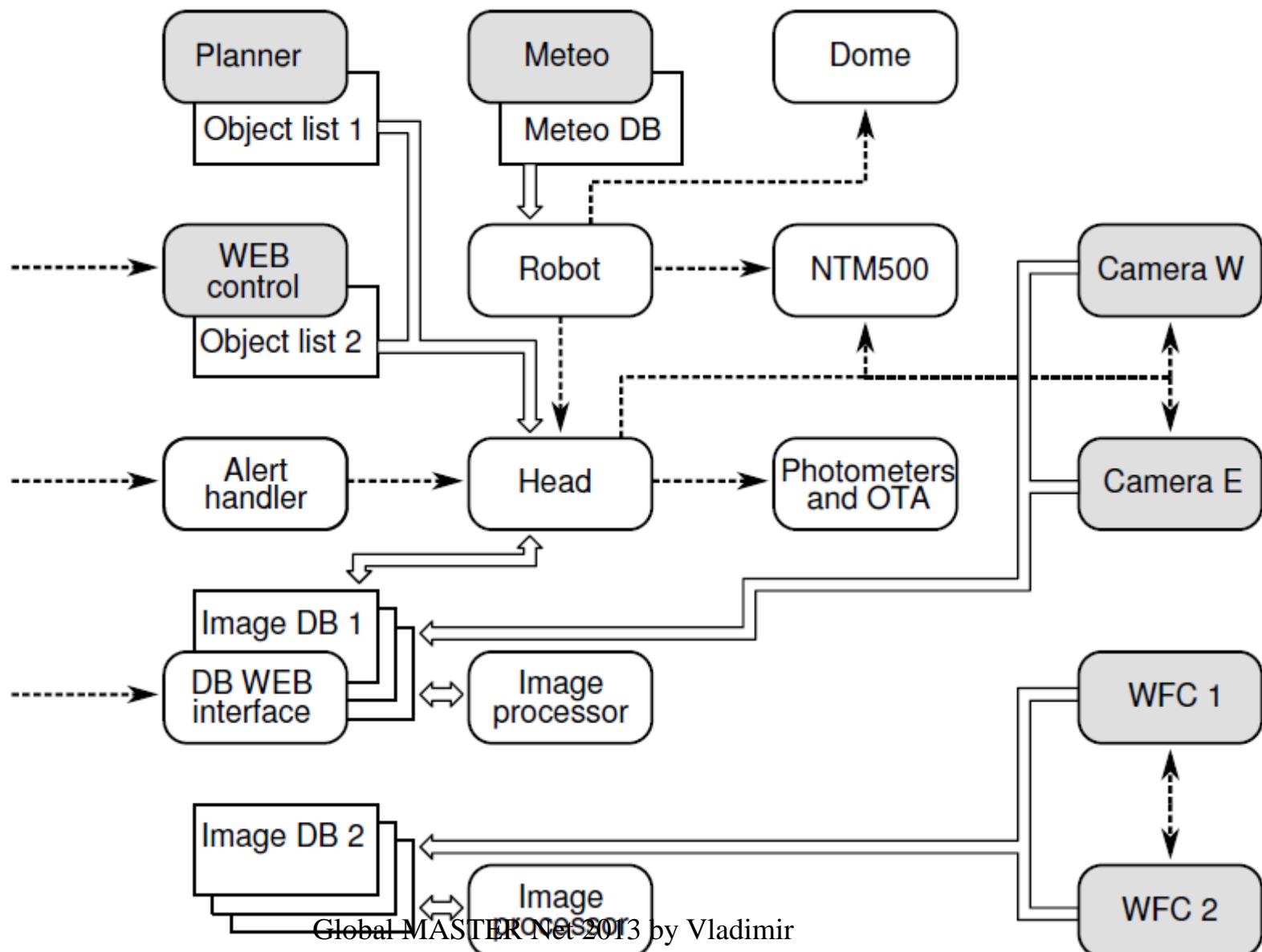
- Very Wide Field Cameras
MACTEP VWF
- FOV=400 square degrees up to 12 mag per 1 s.
- Time Resolution 150 ms

MASTER Photometer



Global MASTER Net 2013 by Vladimir
Lipunov at Gravitational Wave Physics and
Astronomy Workshop, December 17- 20, 2013

Logical Structure of the Observations



MASTER telescope at Caucasus



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Global
Lipunov at
Astrophoto

MASTER-Kislovodsk

MASTER SYSTEM CONTROL CENTER

Kislovodsk



Ural



Tunka



Amur



Vostryakovo



Argentina





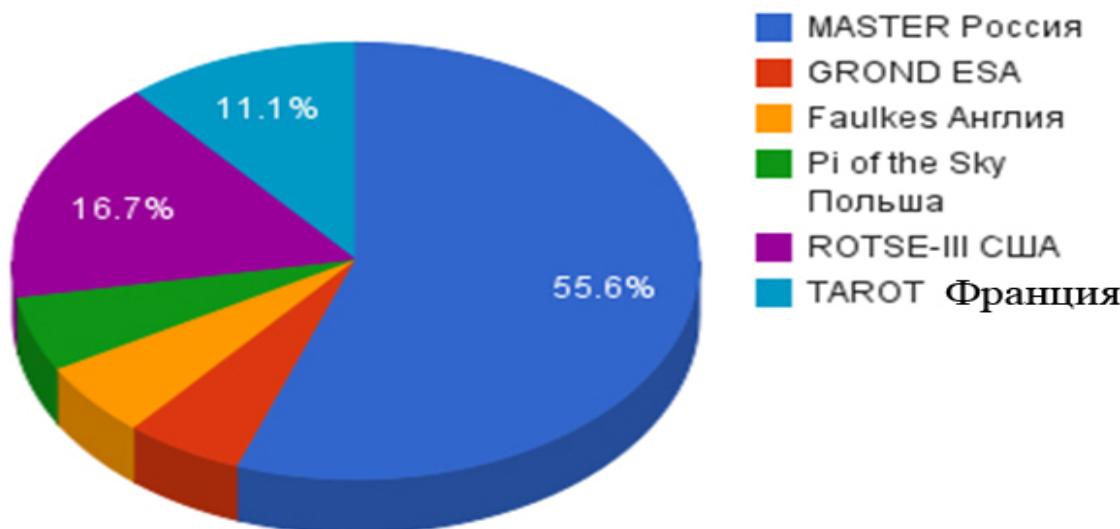
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MACTEP-2013



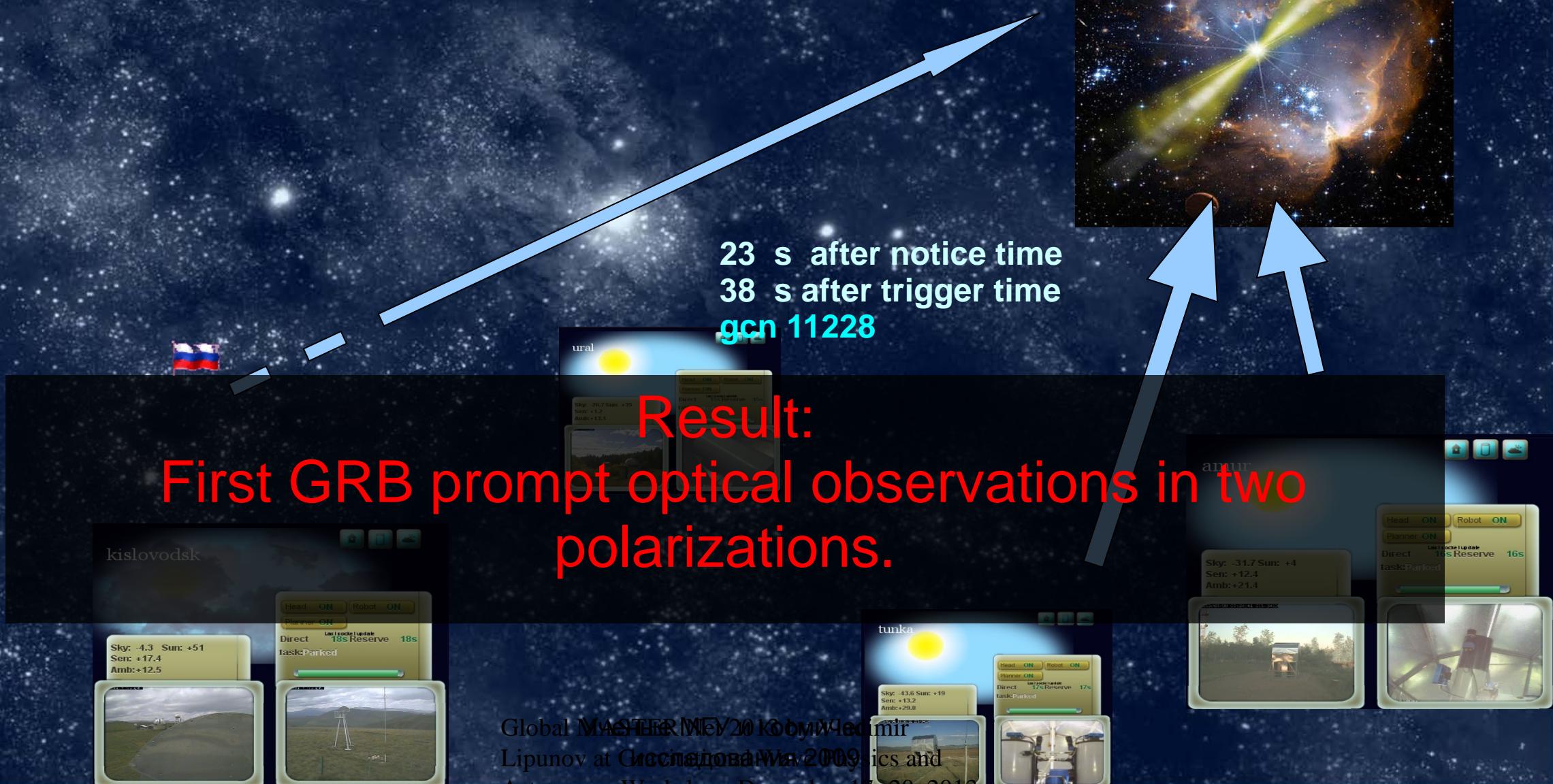
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Statistic of the 66 GRB observations by MASTER (2010-2011 winter, only ground telescopes)

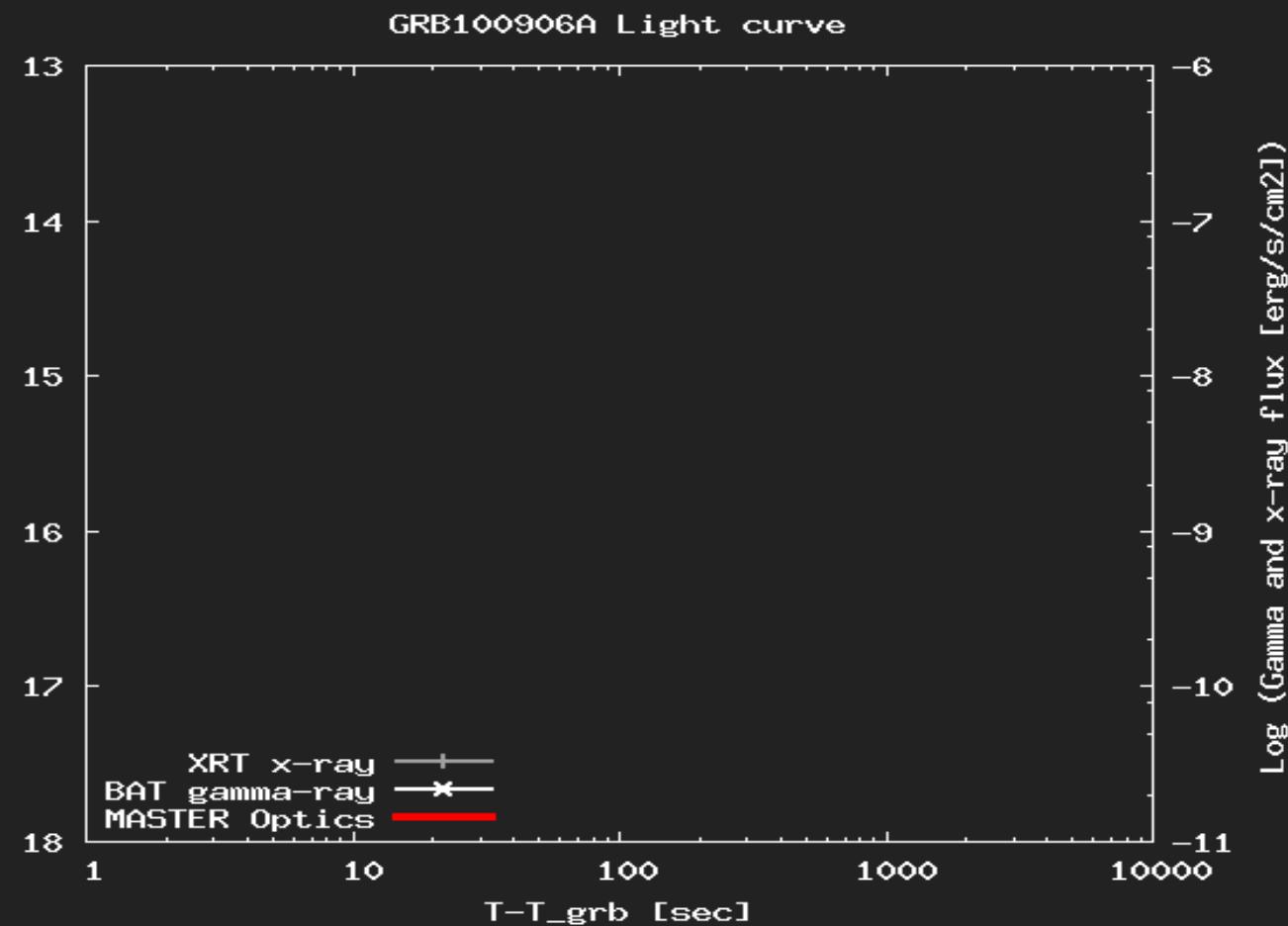
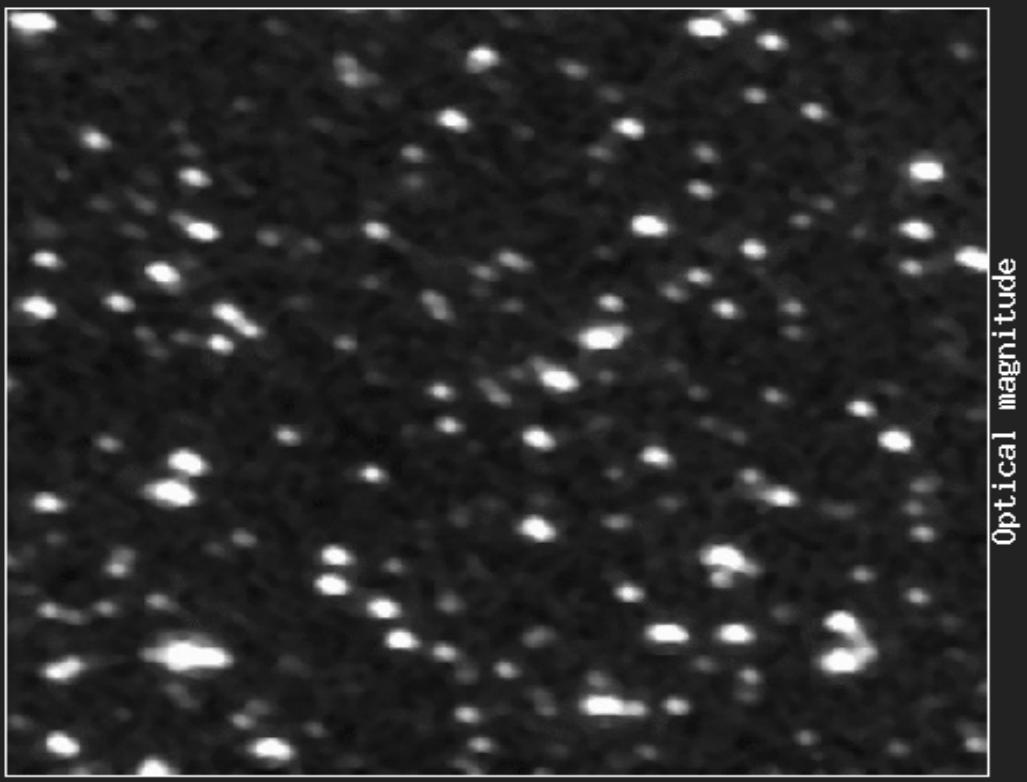


GRB100906A

(gcn11214)



The first in the world synchronous polarized gamma-ray burst observations (the 6 of September 2010, MASTER network)



The left is the optical flair / The distance is about 10^{-9} light years

The right one: white is gamma-ray emission, the gray is the x-ray emission, the red is the optical emission
– оптическое излучение

GRB100906A: Polarization less then 2%

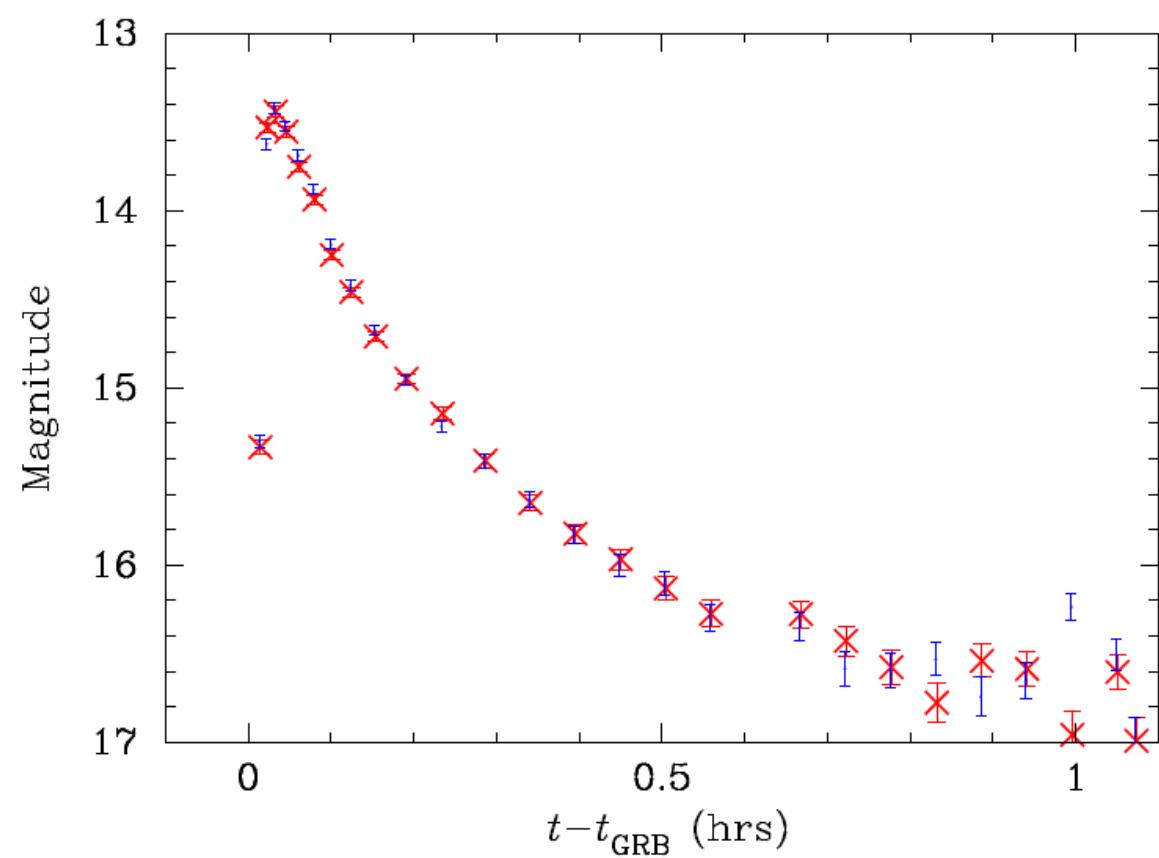
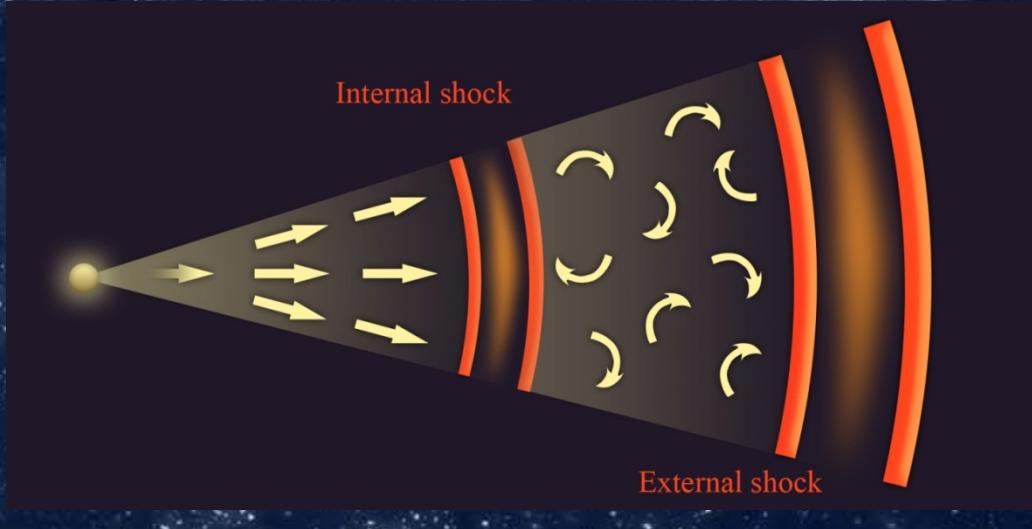
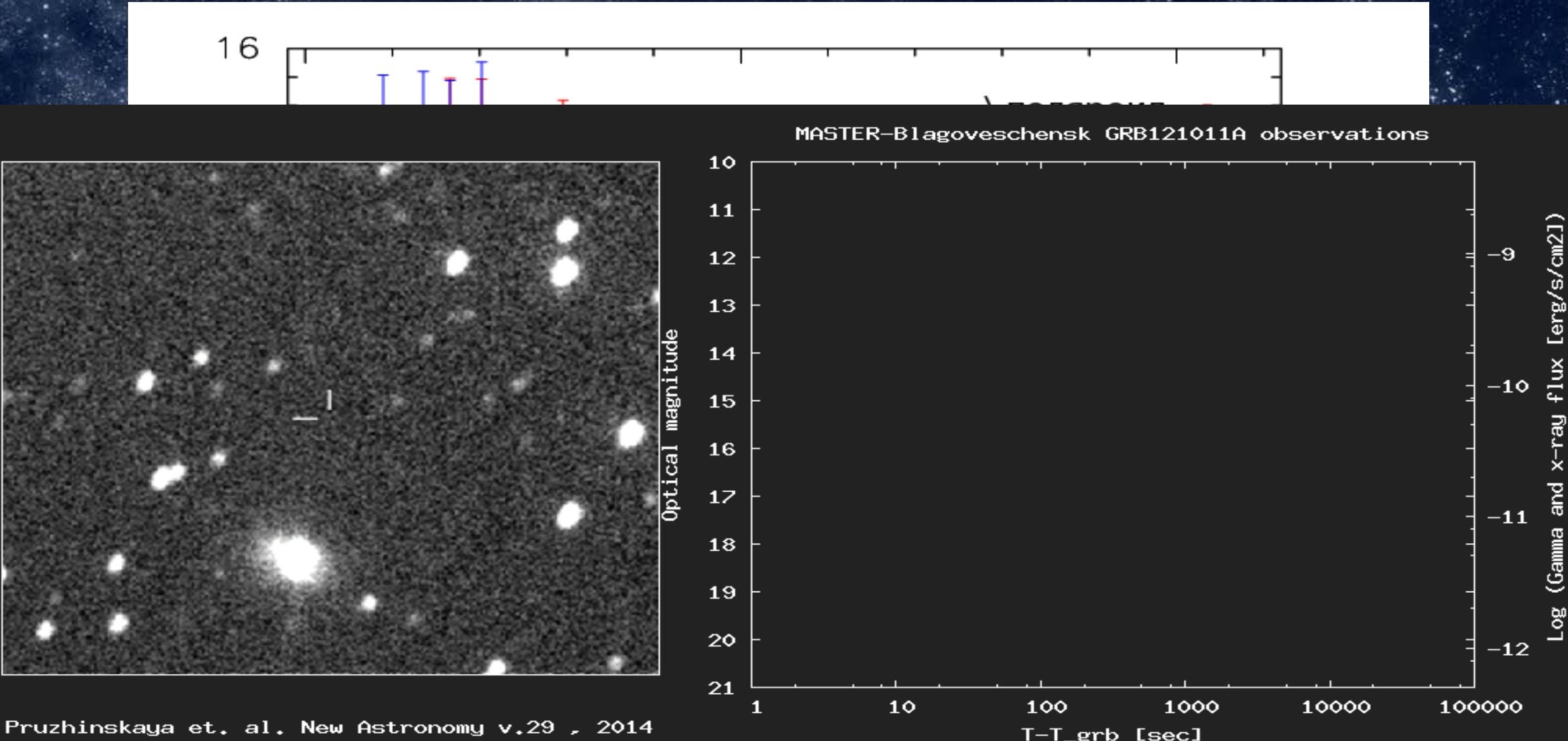
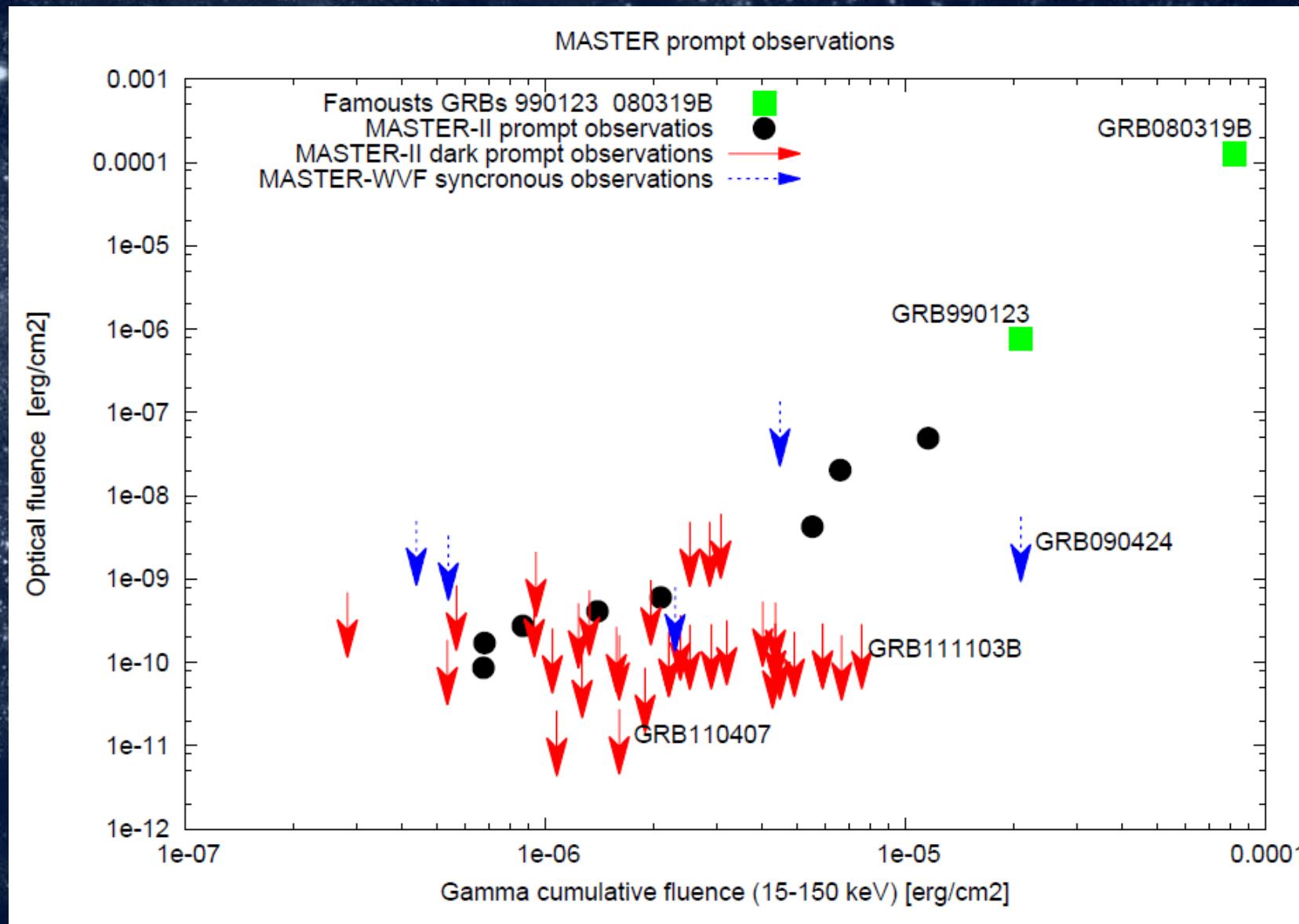


Figure 4. MASTER light curve of GRB 100901A in two polarizations, unfiltered band (blue dots and red crosses). Data are not corrected for the Galactic extinction.

Уникальные поляризационные наблюдения гамма-всплеска GRB 121011A в Благовещенске (Пружинская и др., New Astronomy, 2014).



Optcal SYNCHRONOUS observations of GRB



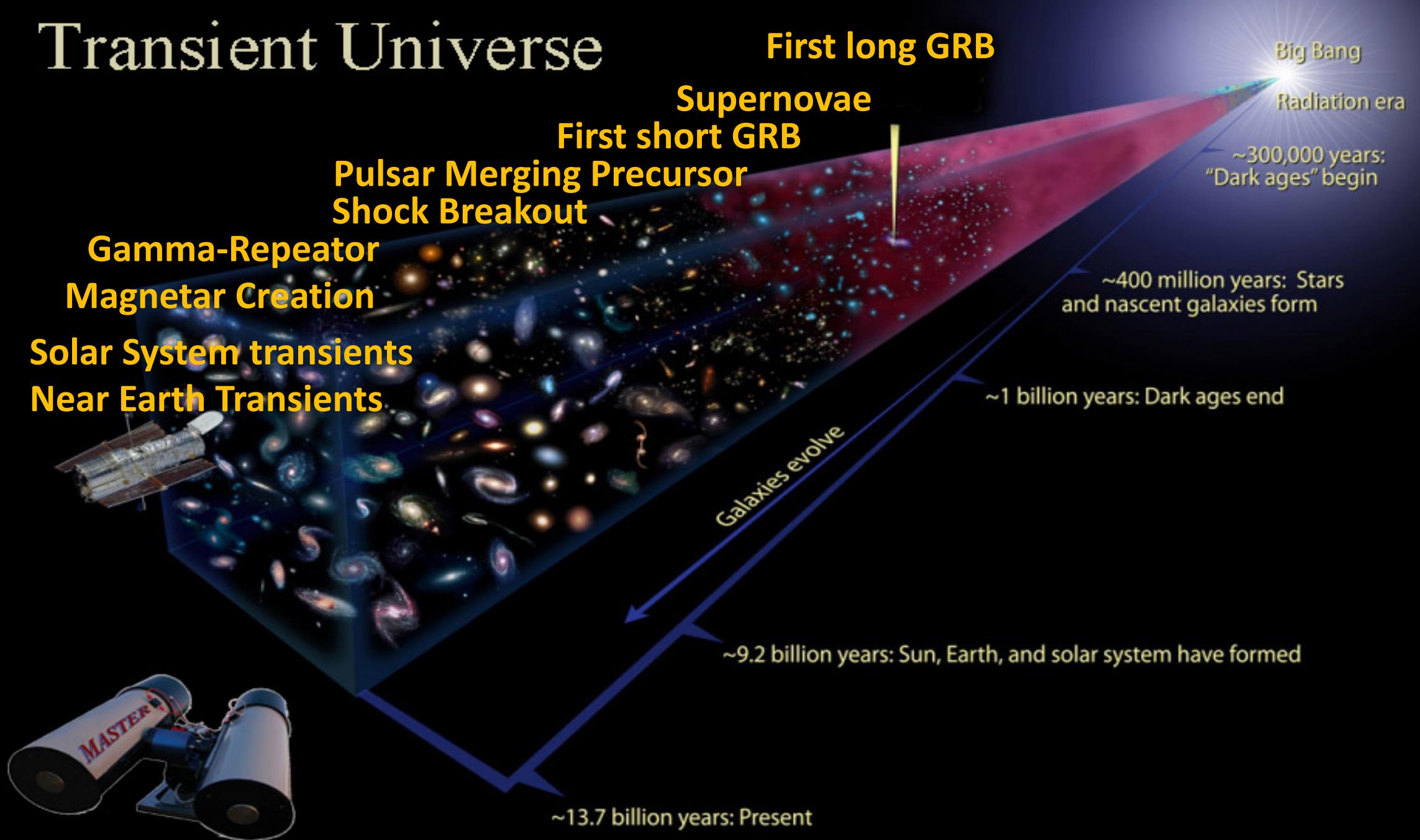
MASTER Net SYNOPTIC SURVEY

(Our dream: one night – one sky up to 20-21 m)

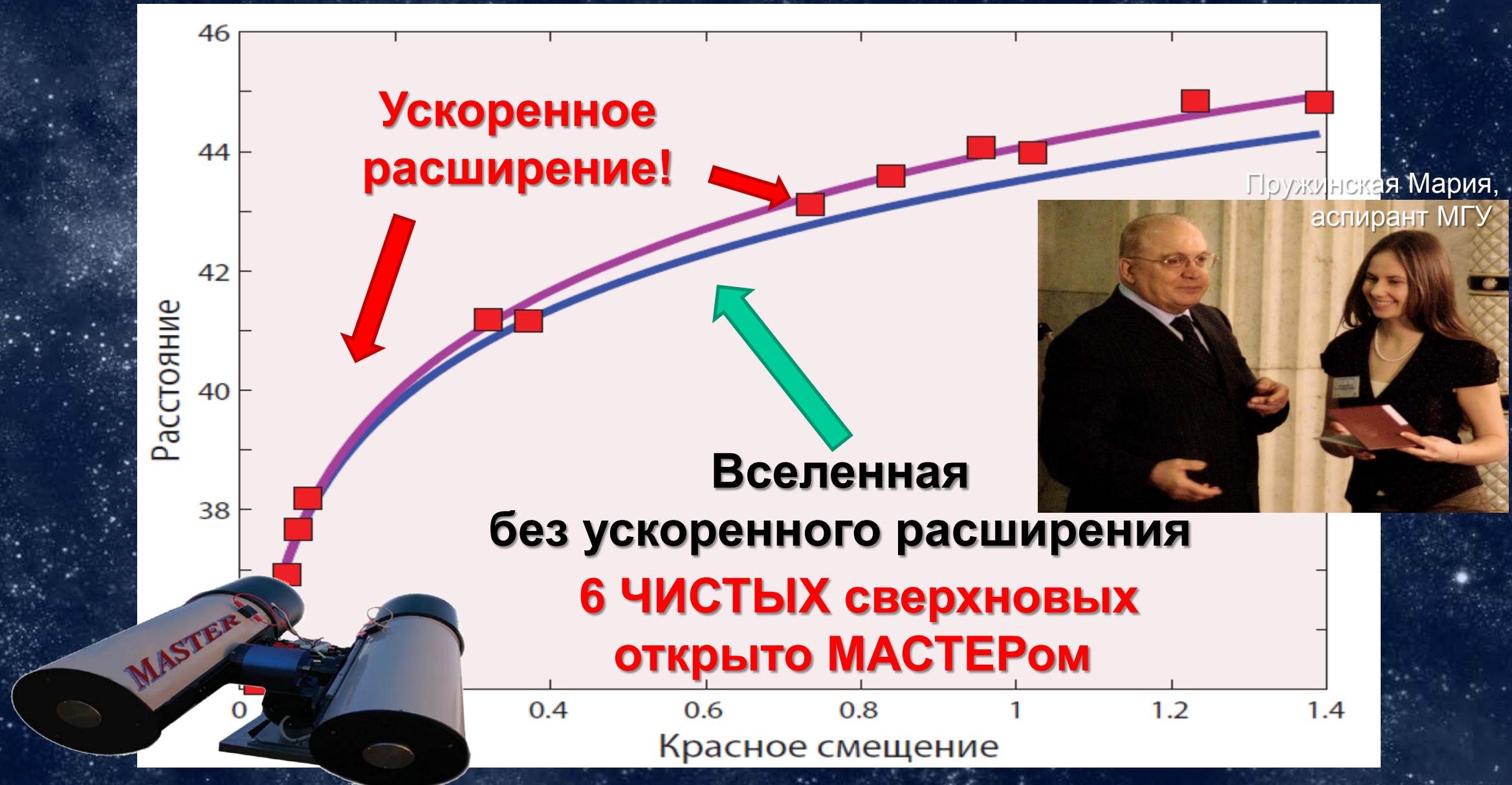


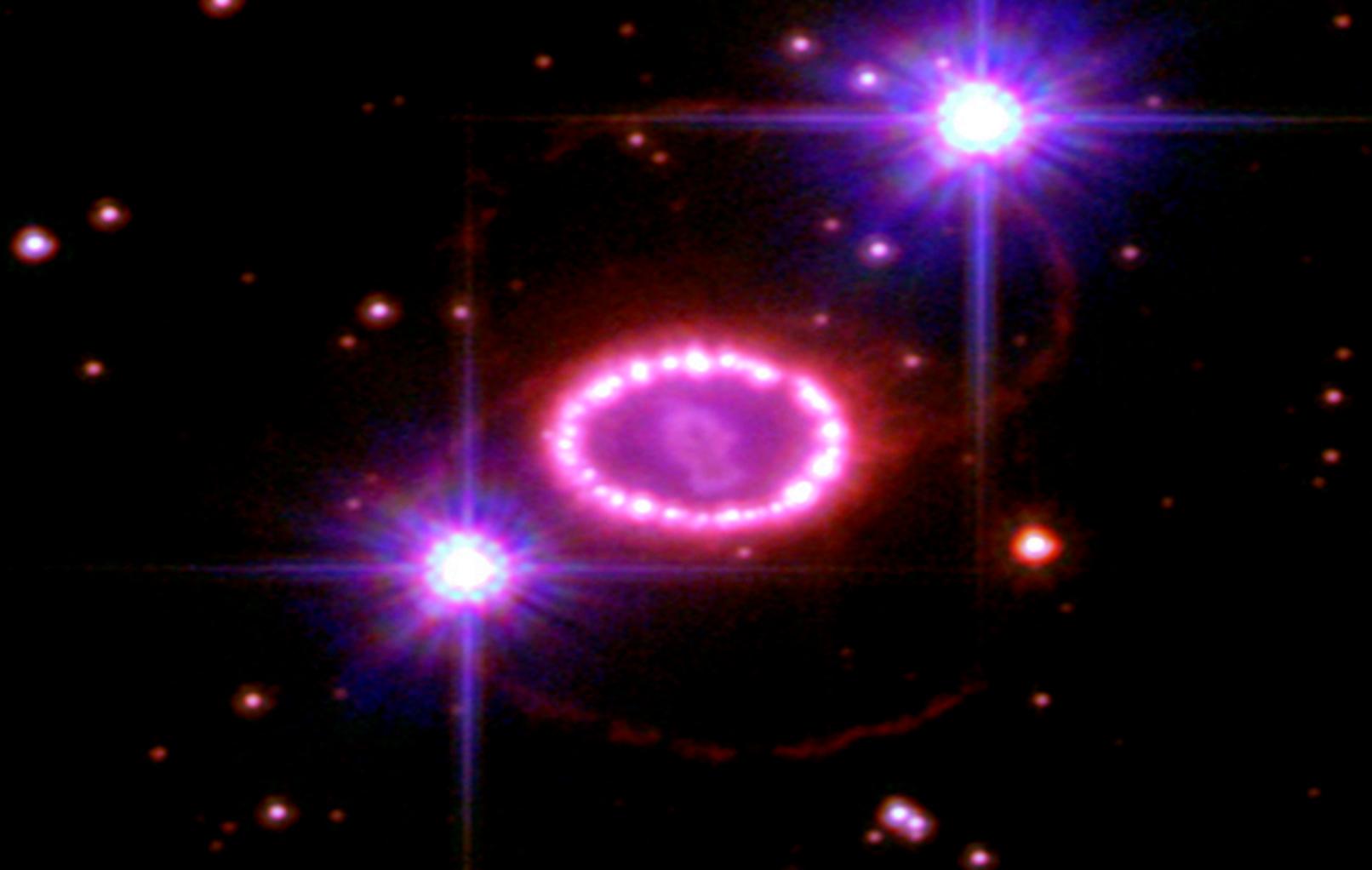
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Transient Universe

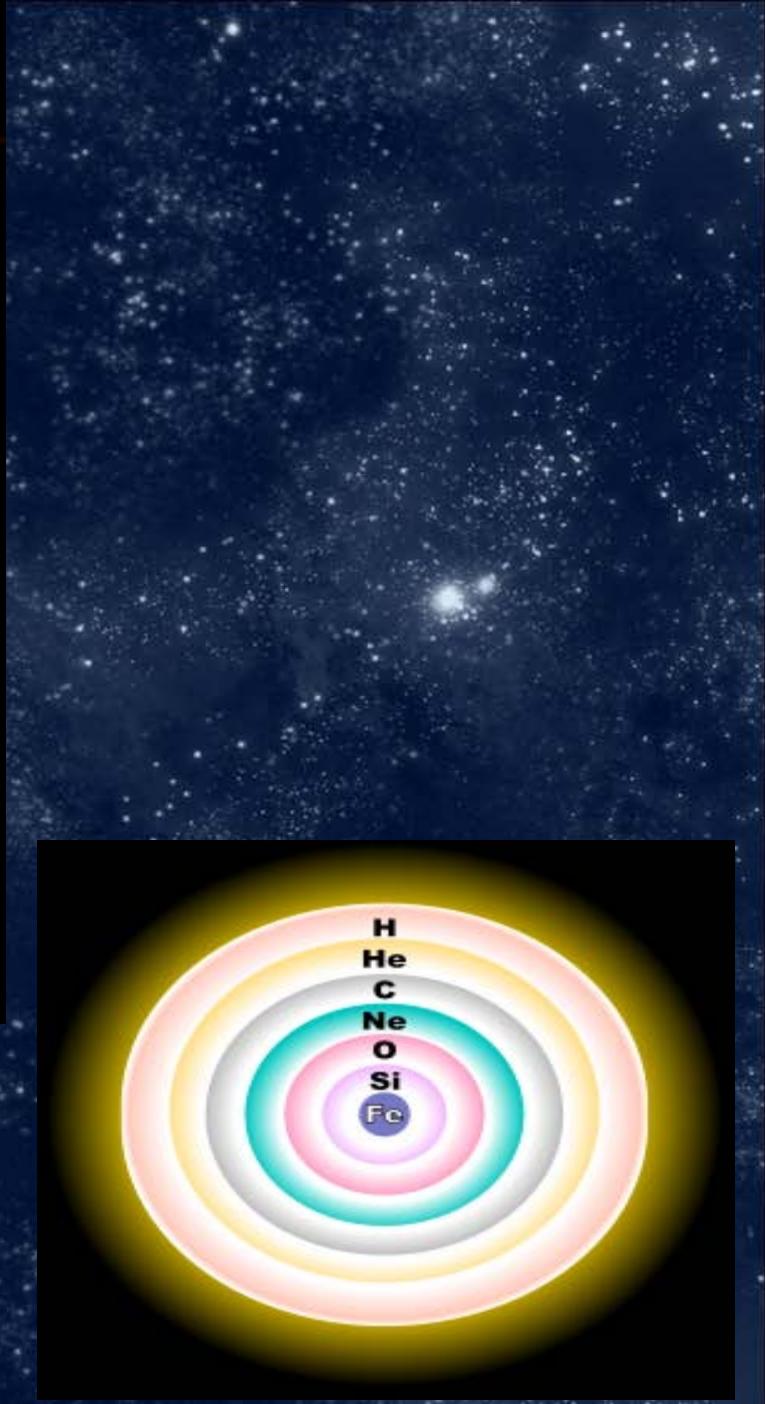


Новый класс СВЕРХНОВЫХ звёзд





The expanding remnant of SN 1987A, a Type II-p supernova in the Large Magellanic Cloud. NASA image



Survey Information Flow

MACTEP II telescopes

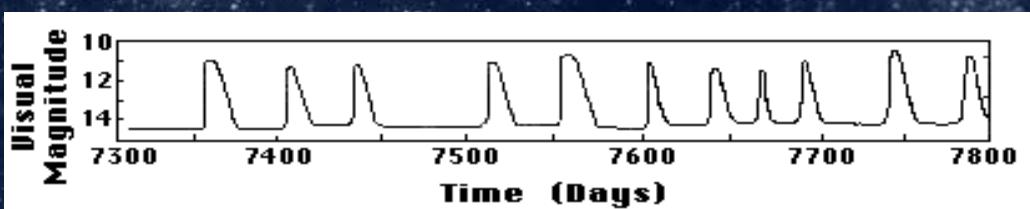
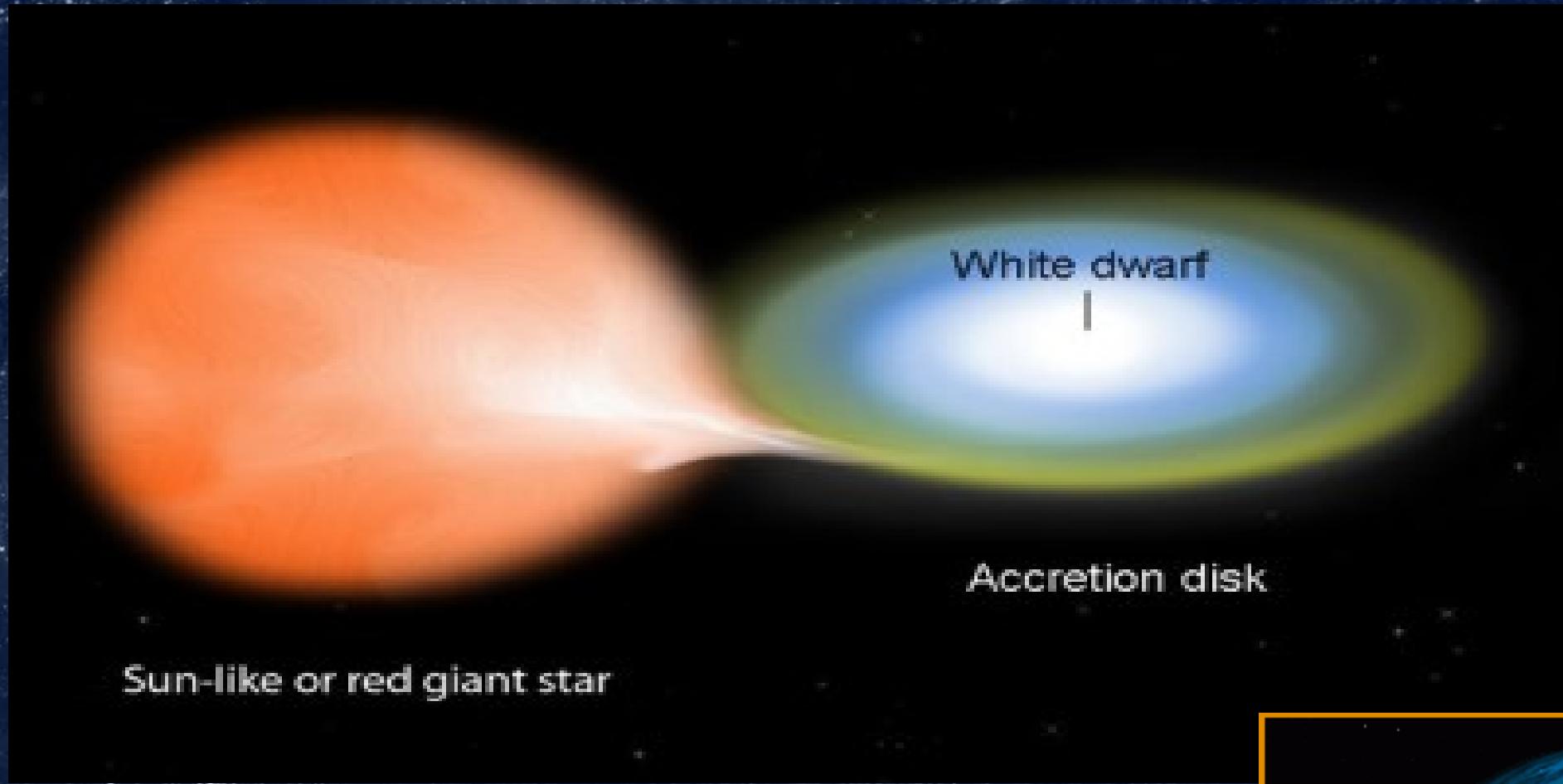
Info Flow = $4 \times 15\text{Gb} = 60\text{Gb/night}$

Common FOV = 32 square degrees up to 21 mag

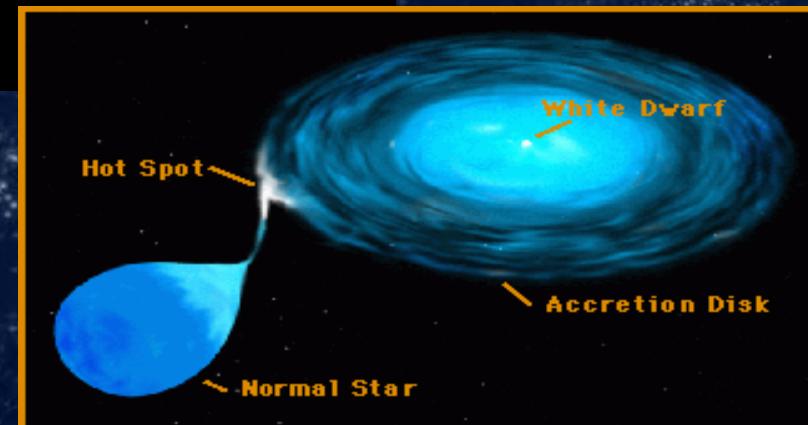
MACTEP VWF cameras

$12 \times 950 \text{ Gb/night} = 10\text{Tb/night}$

Common FOV = 4800 square degrees up to 14 mag

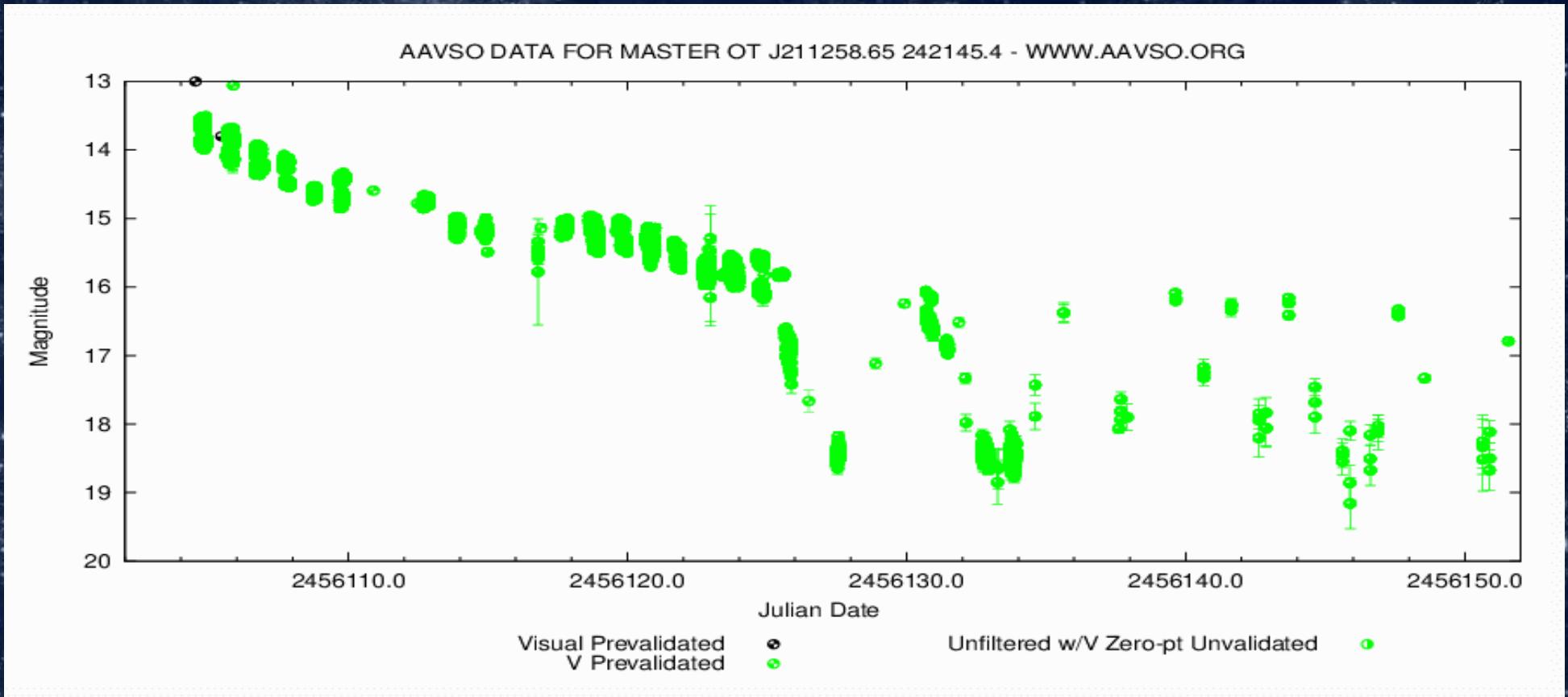


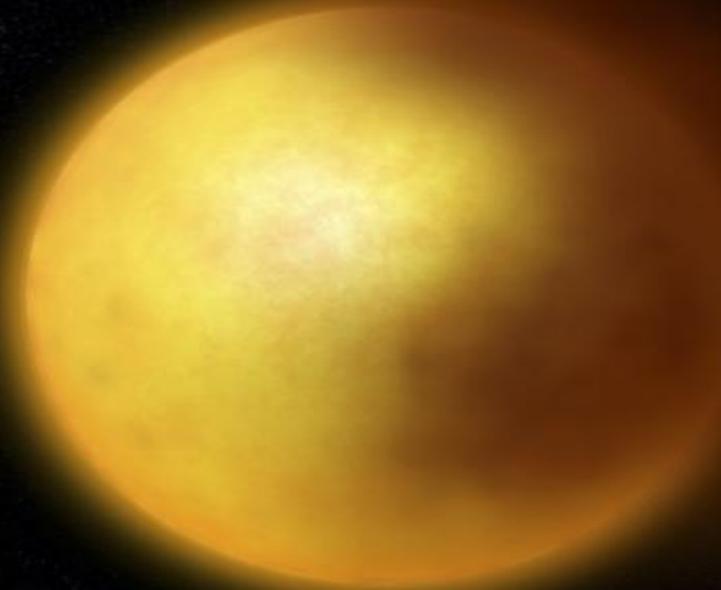
500 day light curve of the dwarf nova SS Aur.



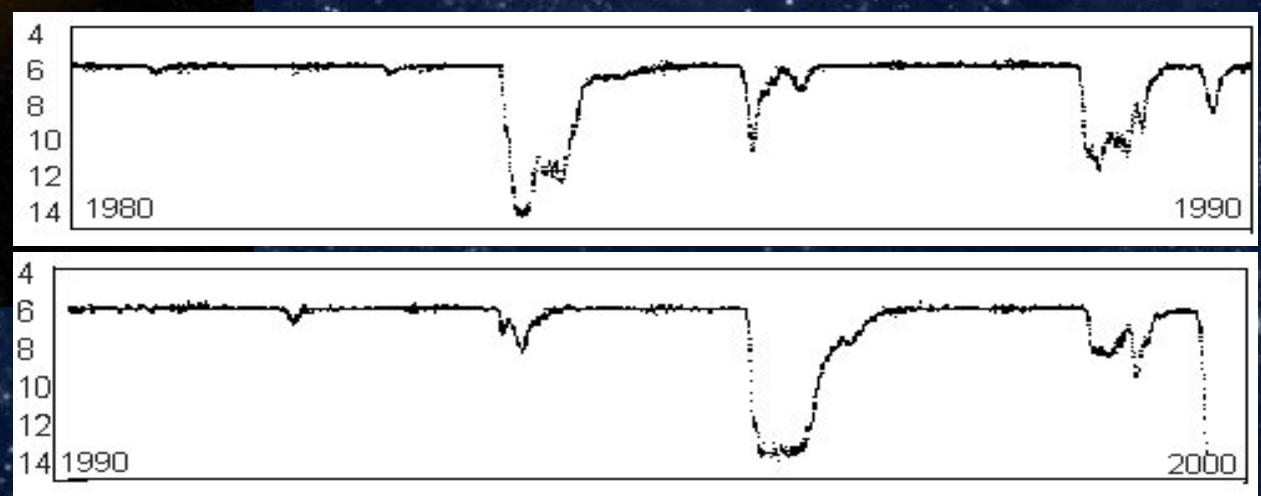
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11000+ observations in 50 days after the discovery by MASTER, 7 rebrightenings

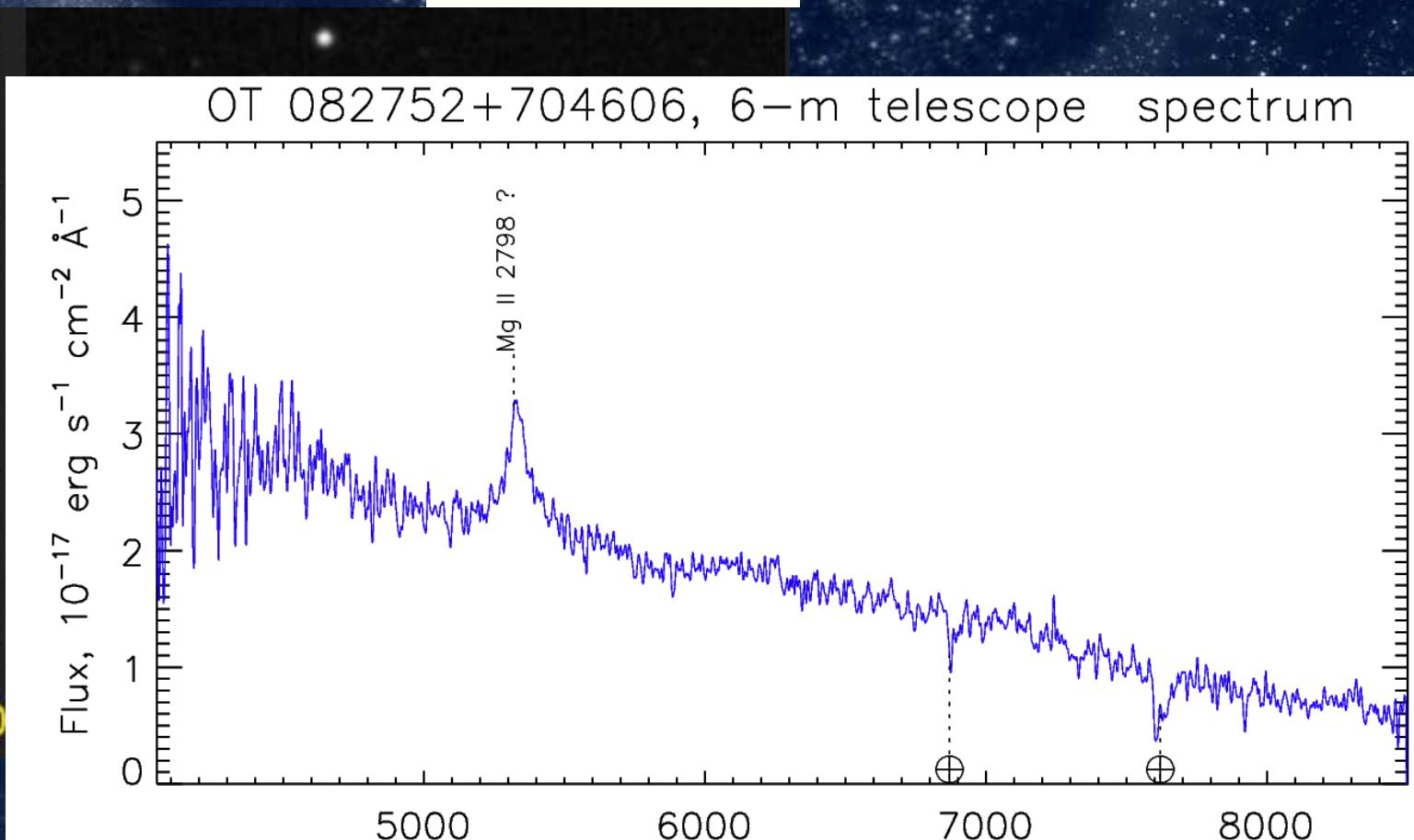




AAVSO light curve of R Coronae Borealis from 1980 to 1999



Single Line OT: OT082752+704606



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Synoptic Telescope Theorem

If you design synoptic telescope with diameter

$$D,$$

You must have spectral telescope with diameter

$$\sim 10 D.$$

12 мая 2008 года

Typical Near Earth Transient
GLONASS Sat. **26566COSMOS 2374**
observed by MASTER VWFC

Observed:

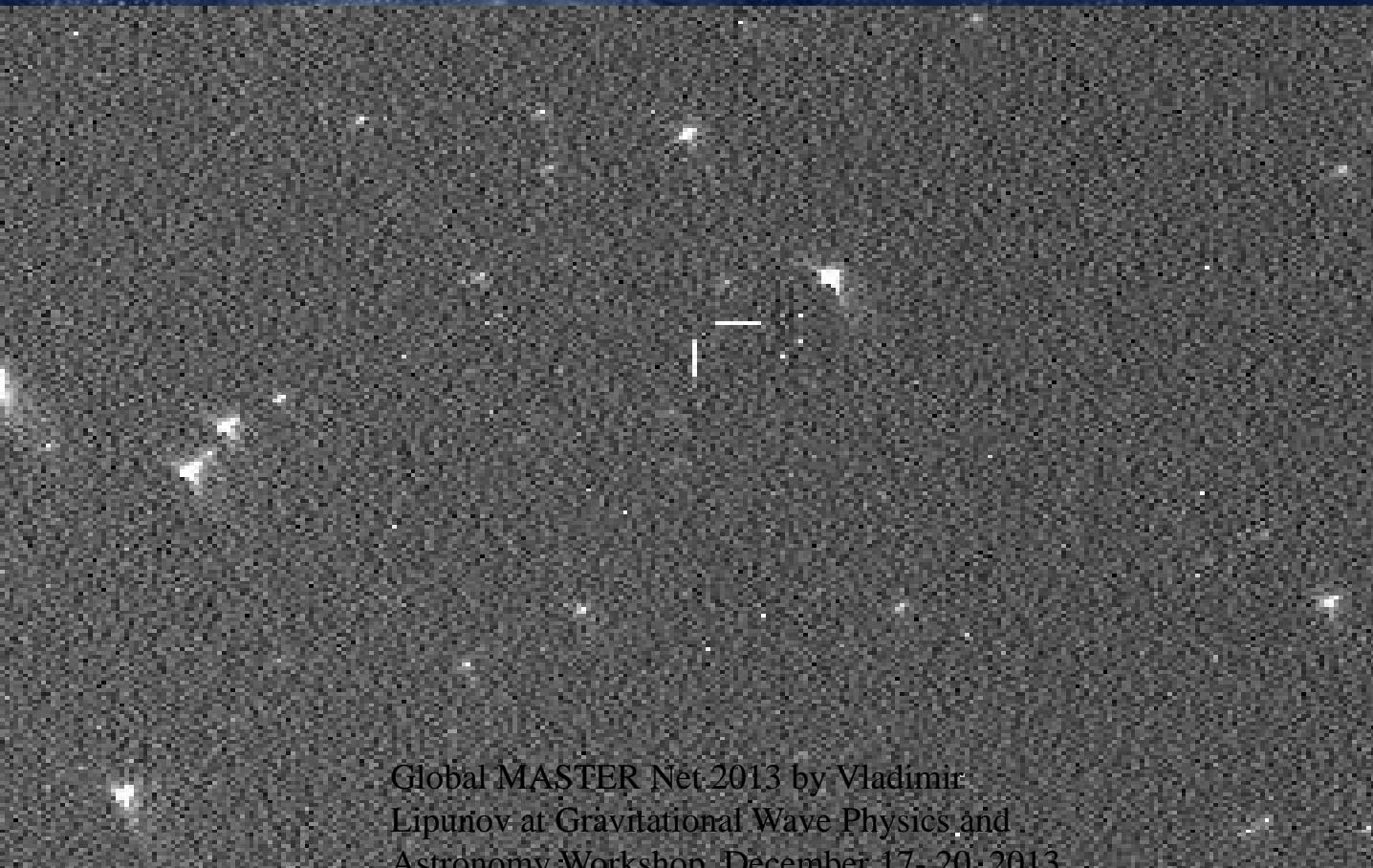
RA = 13h 30m 02s

Dec = +52d 43' 21"

Real:

RA = 13h 29m 59.35s

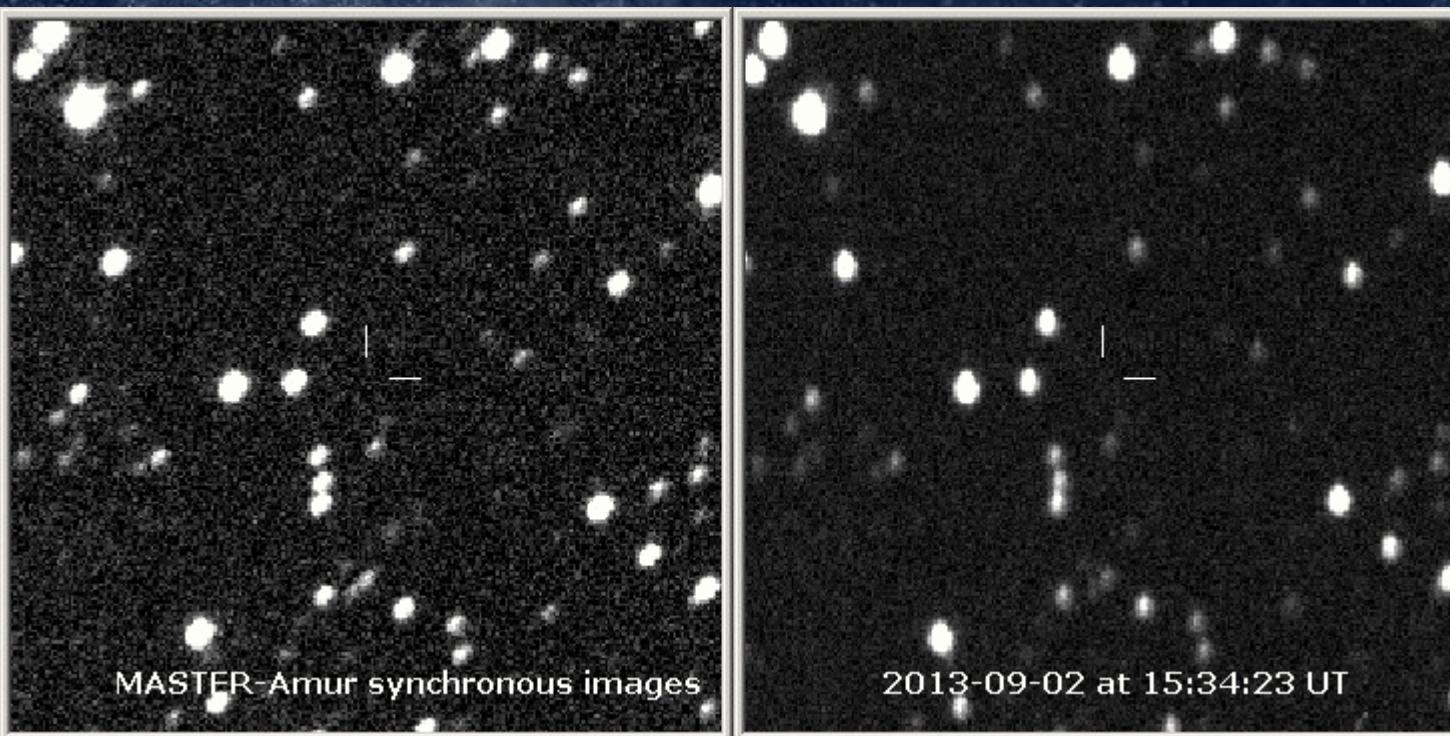
Dec = +52d 42' 45.1"



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MASTER detection of Rapid Optical Transient near the Intriguing Object

MASTER OT J002631.09+444127.4 ATEL 5360
on 4 Sep 2013; 15:59 UT

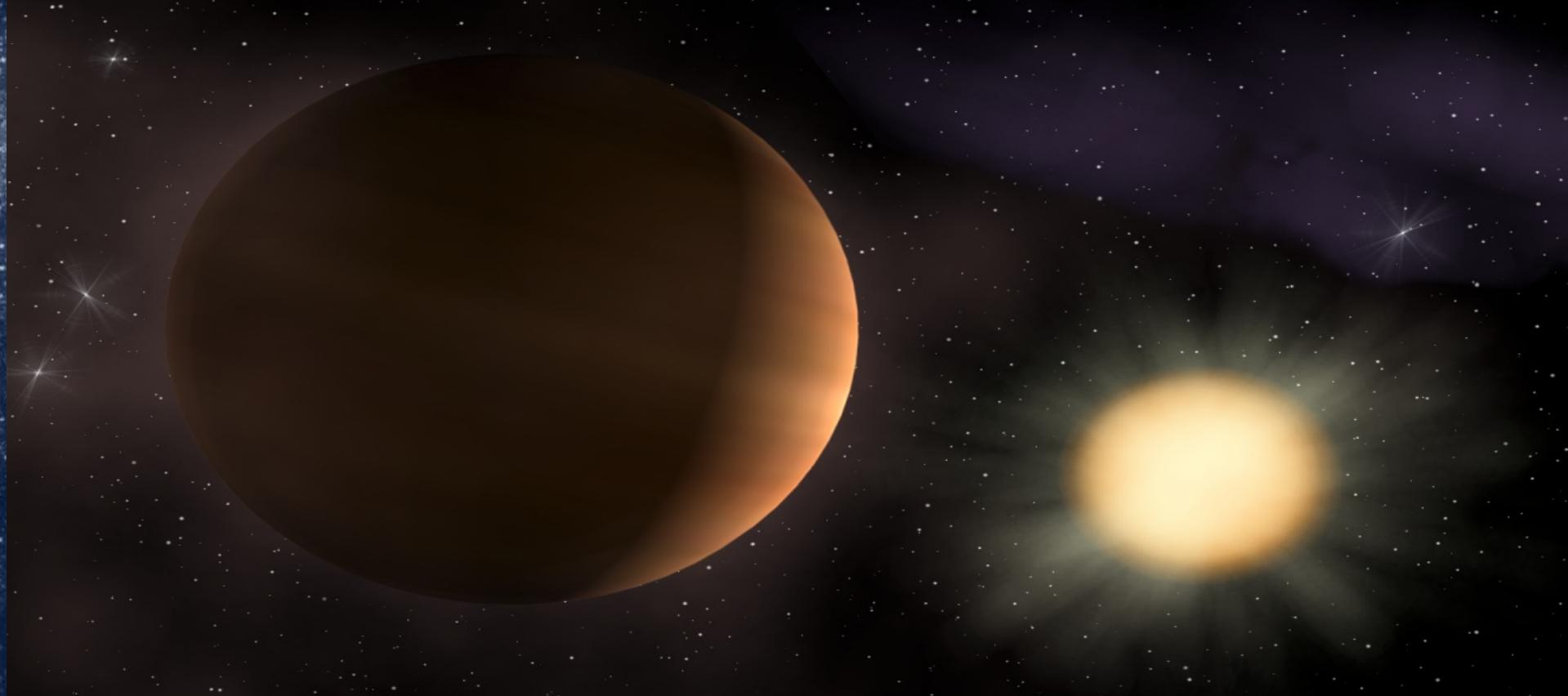




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Chart: RRIB

Exoplanets



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First MASTER Exoplanet candidates MASTER-1b MASTER-Ural (Krushinsky и др., 2013г.)

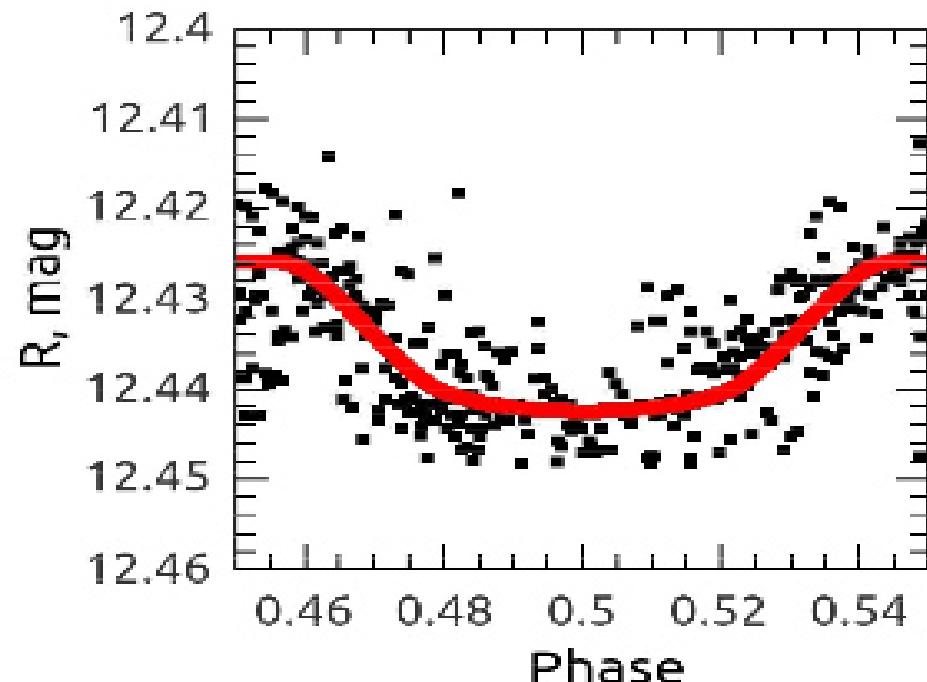
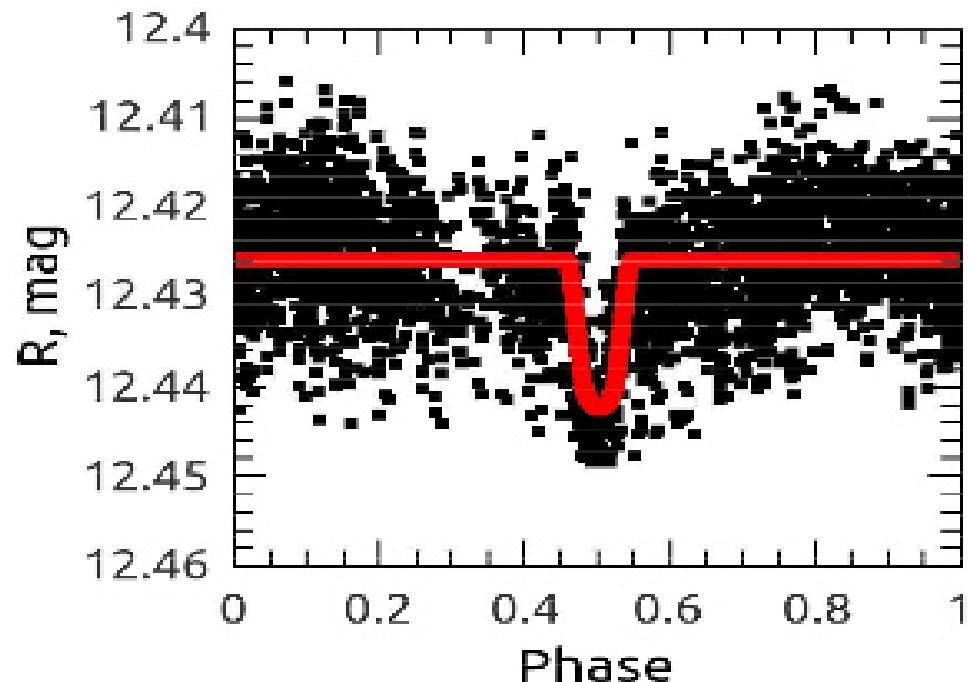


Figure 2. The phased light curve for the MASTER-1 b candidate.

MASTER-2b

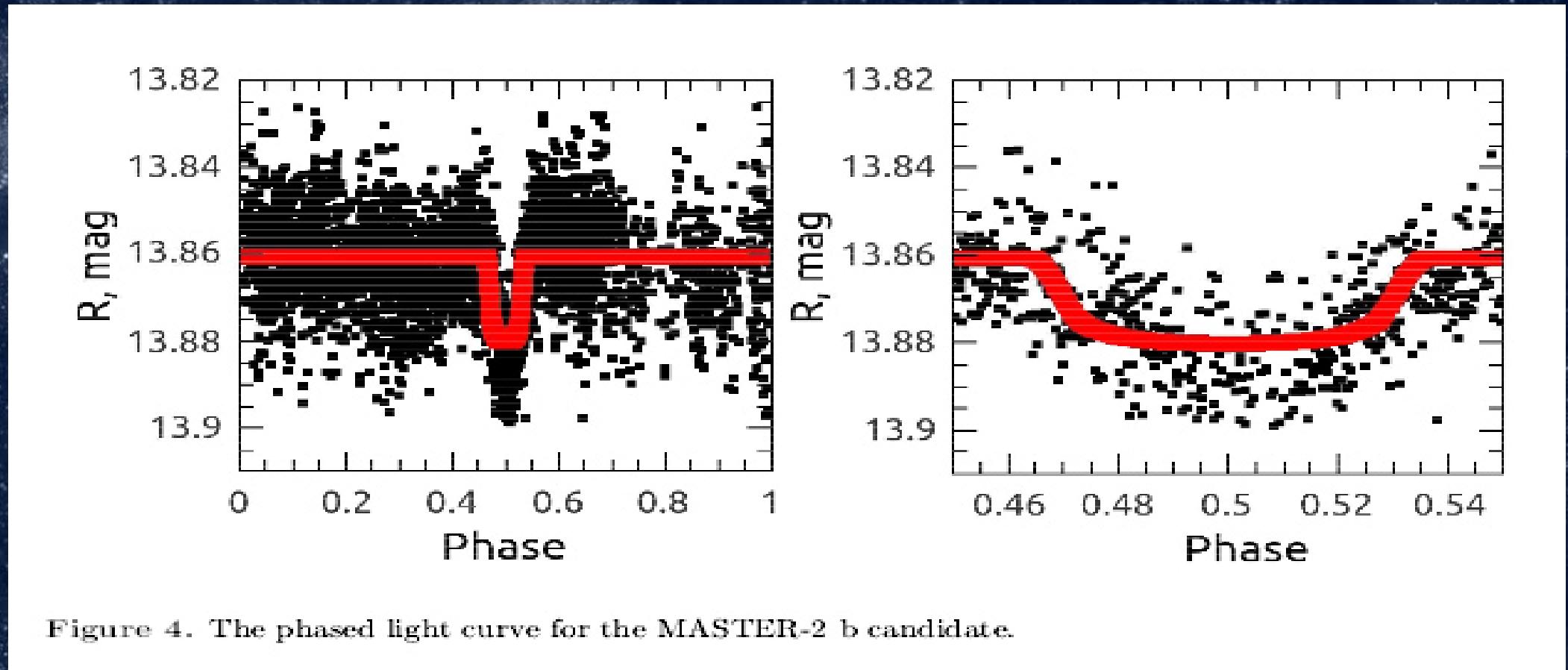
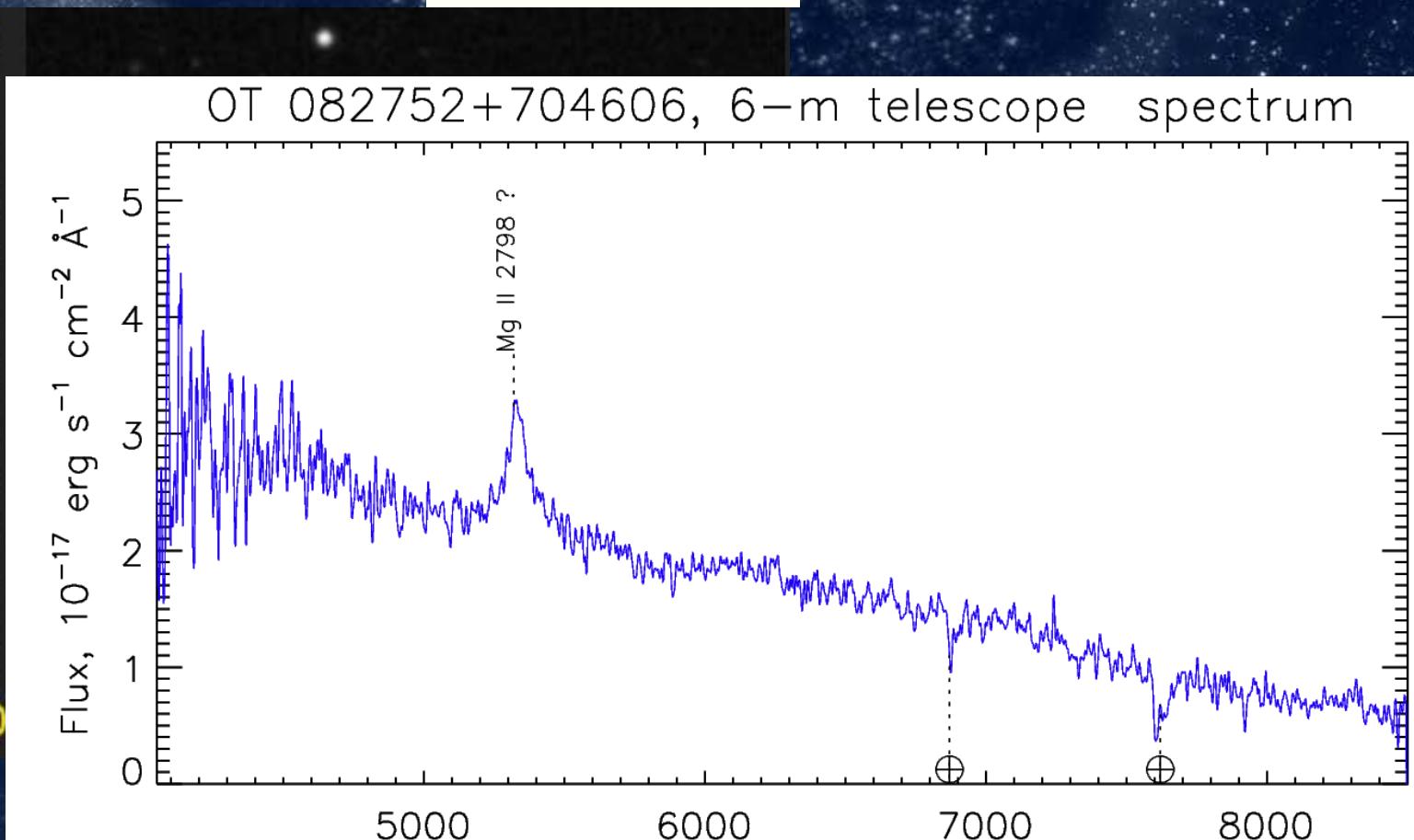


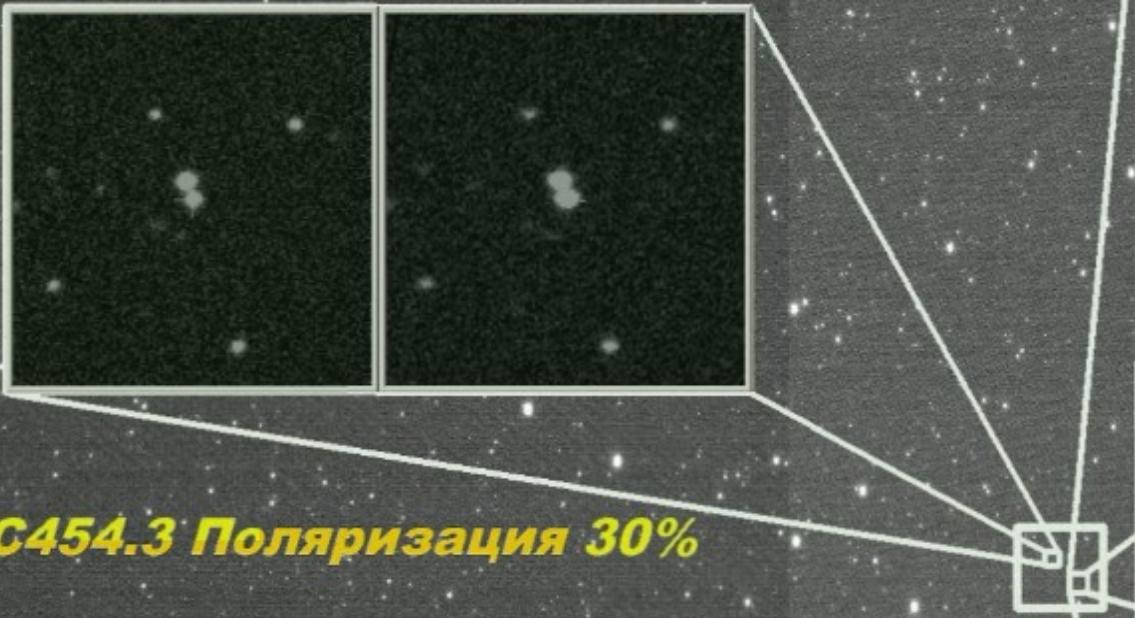
Figure 4. The phased light curve for the MASTER-2 b candidate.

Single Line OT: OT082752+704606

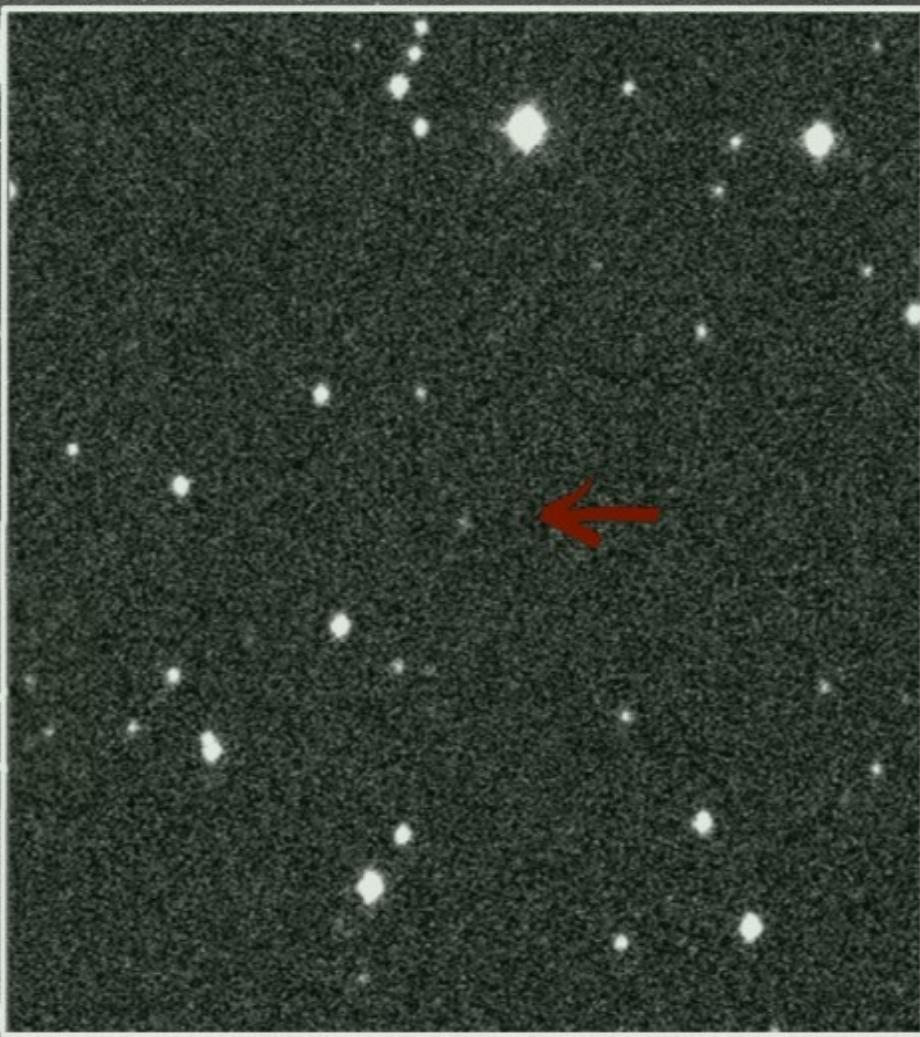


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Открытие околоземного астероида системой МАСТЕР



Квазар 3C454.3 Поляризация 30%



2013-09-27 13:28:26 UT

Лаборатория космического мониторинга МГУ



Глобальная сеть МАСТЕР

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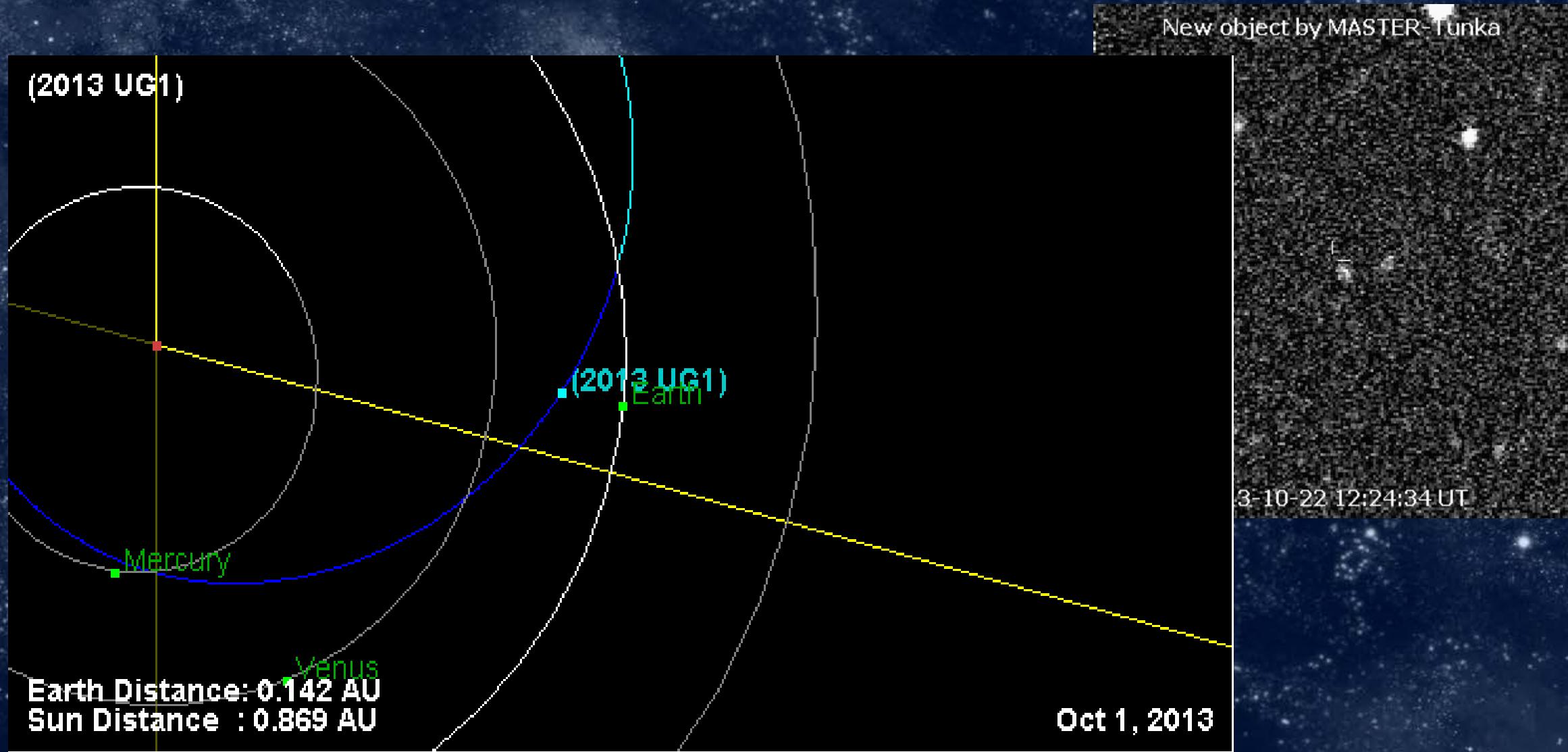
Лаборатория космического мониторинга МГУ

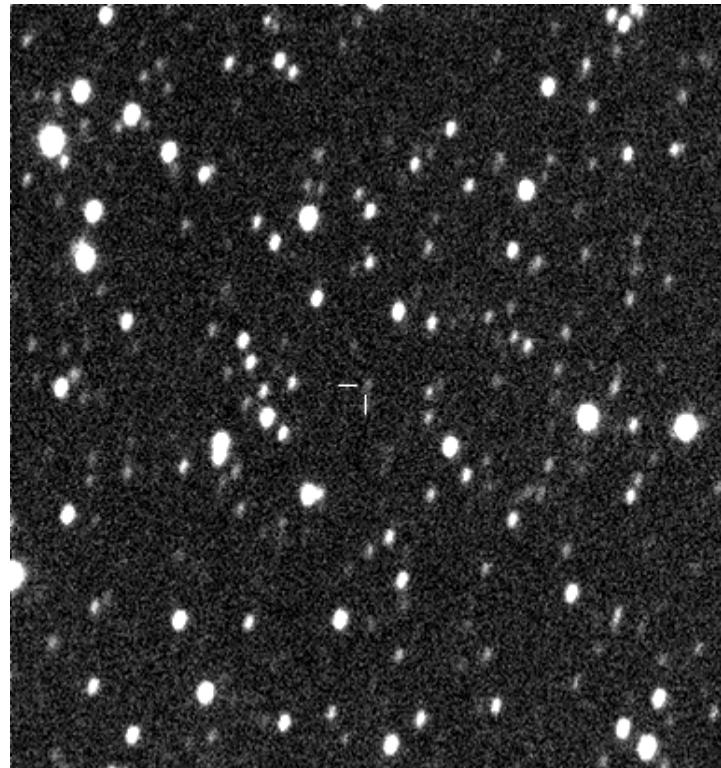
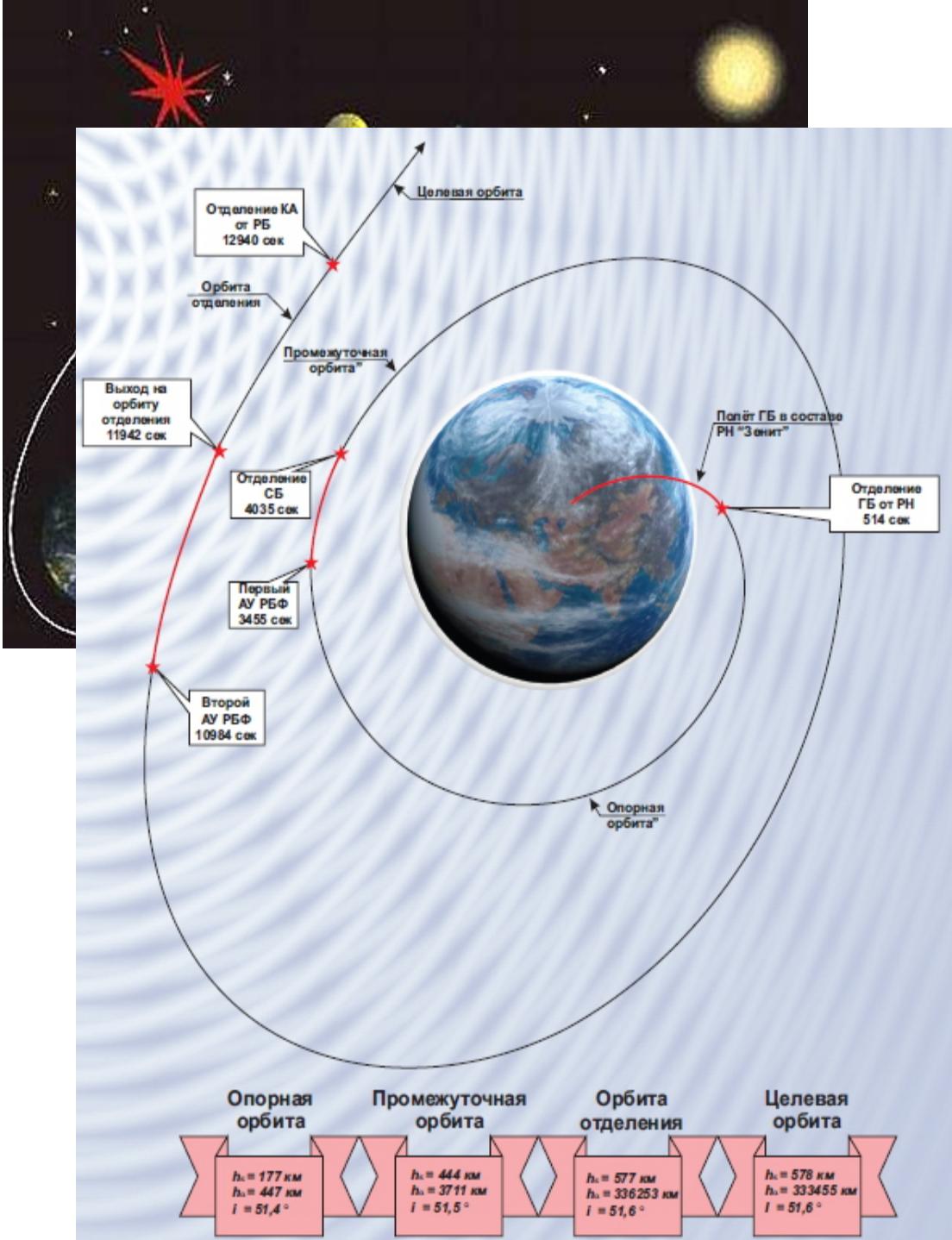


Глобальная сеть МАСТЕР



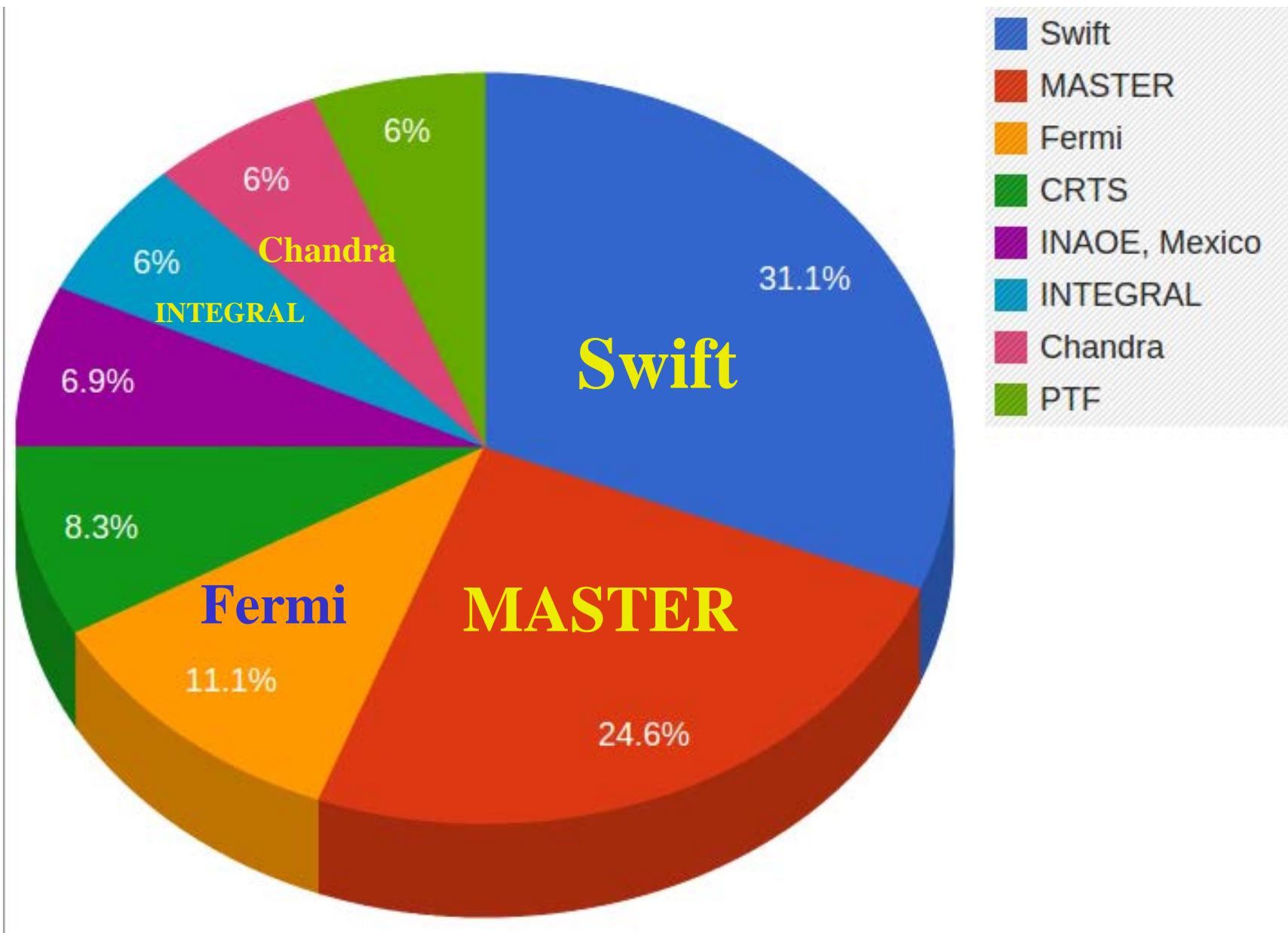
Потенциально-опасный астероид 2013UG1. Открыт МАСТЕР-Тунка 22 октября 2013 года.





by Vladimir
Dave Physics and
ember 17- 20 2013

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500 новых космических объектов, открытых телескопами МАСТЕР

1

2005 Apr. 20.939

Discovered by
N. Tiurina

MASTER-NET transients sky

14h 24m 07.44s
+26d 17m 50.3s
Mag=16.5
CBET #146



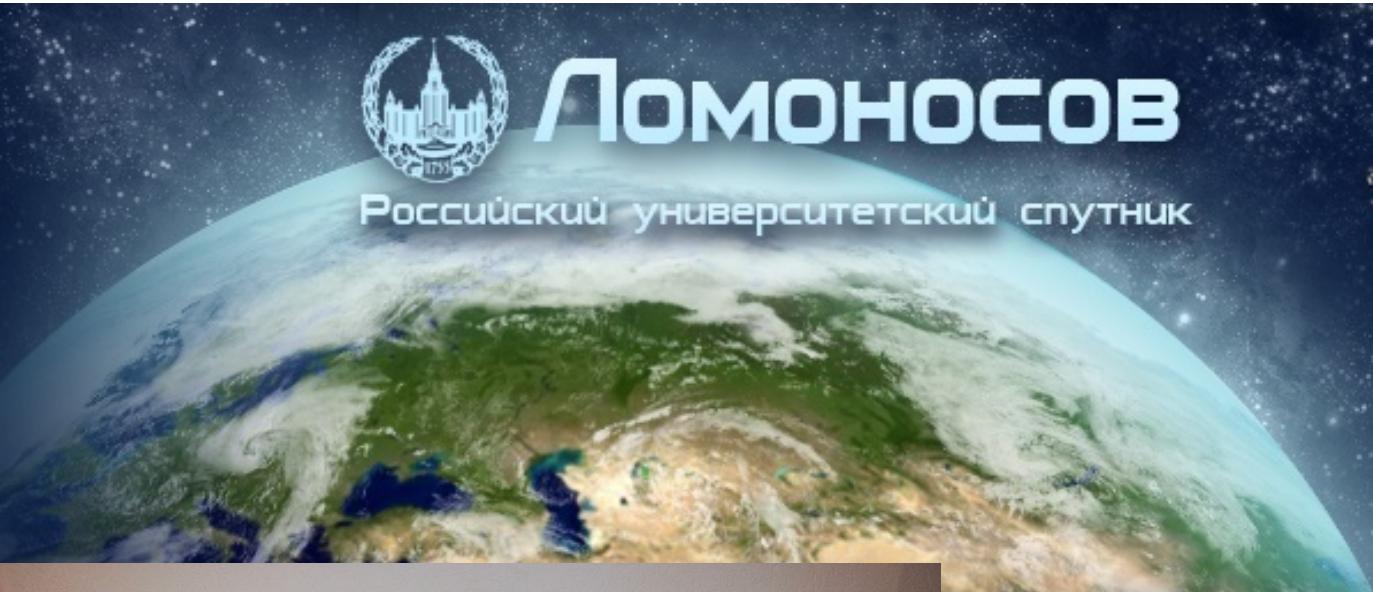
Moscow (Vostriakovo)

Supernova

Робот-телескопы МАСТЕР



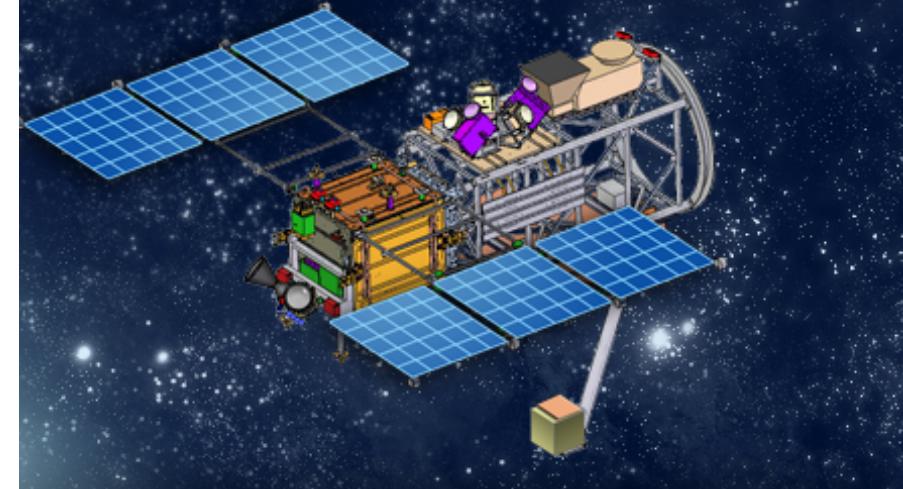
ЛОМОНОСОВ
Российский университетский спутник



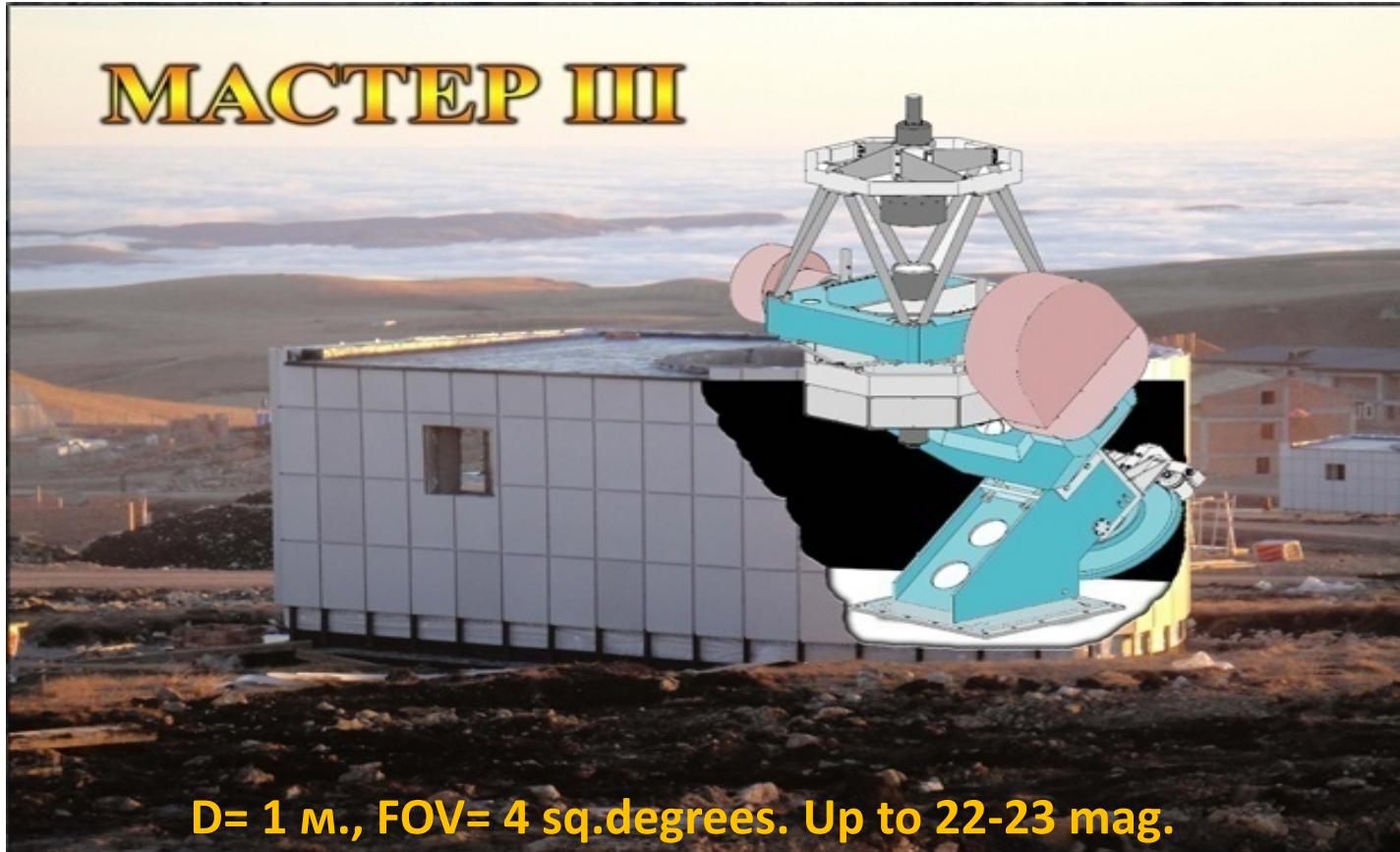
Prompt Optical High Time Resolution Observations

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Lipunov at Gravitational Wave Physics and

2015



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Работающие и планируемые поисковые проекты

