

Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών

ΜΕΘΟΔΟΙ ΠΑΡΑΤΗΡΗΣΗΣ

Κοσμάς Γαζέας



Μέθοδοι και τεχνικές παρατήρησης

Απεικόνιση - Imaging

- Εξαγωγή πληροφοριών από εικόνες

Φωτομετρία - Photometry

- Μεταβλητοί αστέρες, εκρήξεις και εκλείψεις αστερων, τροχιές, κ.α.

Φασματοσκοπία - Spectroscopy

- Μέτρηση ταχυτήτων, υπολογισμός τροχιών, μαζών κ.α.

Αstrometρία - Astrometry

- Προσδιορισμός θέσης, τροχιών, κινήσεων

Συμβολομετρία - Interferometry

- Αύξηση διακριτικής ικανότητας, λεπτομερής μελέτη αστερων

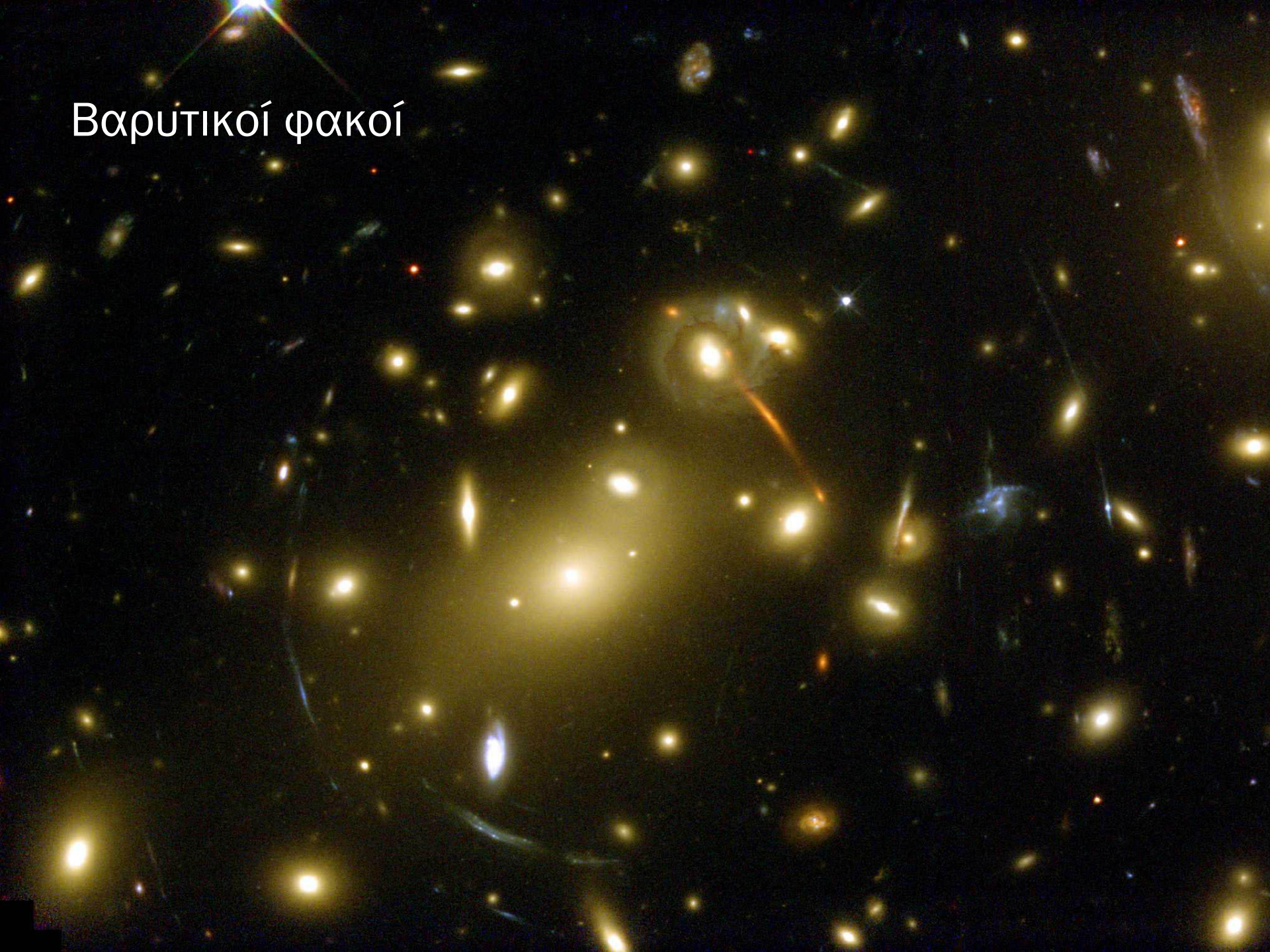
Πολωσιμετρία - Polarimetry (Magnetometry)

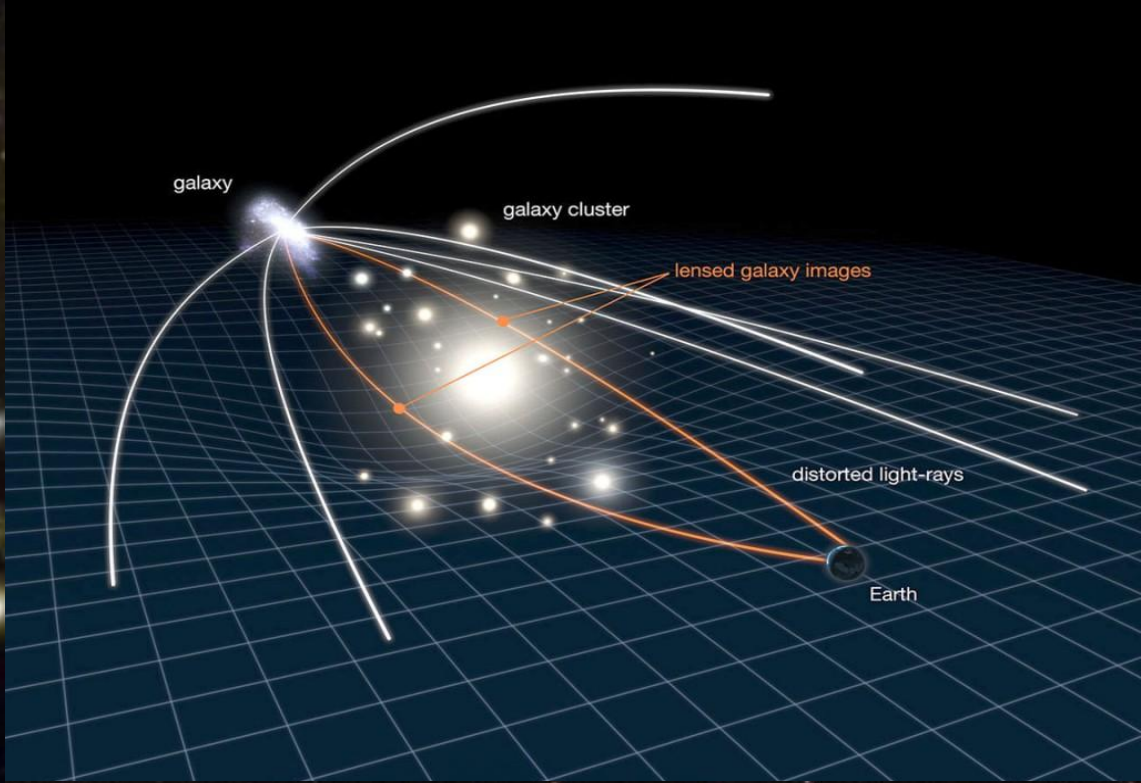
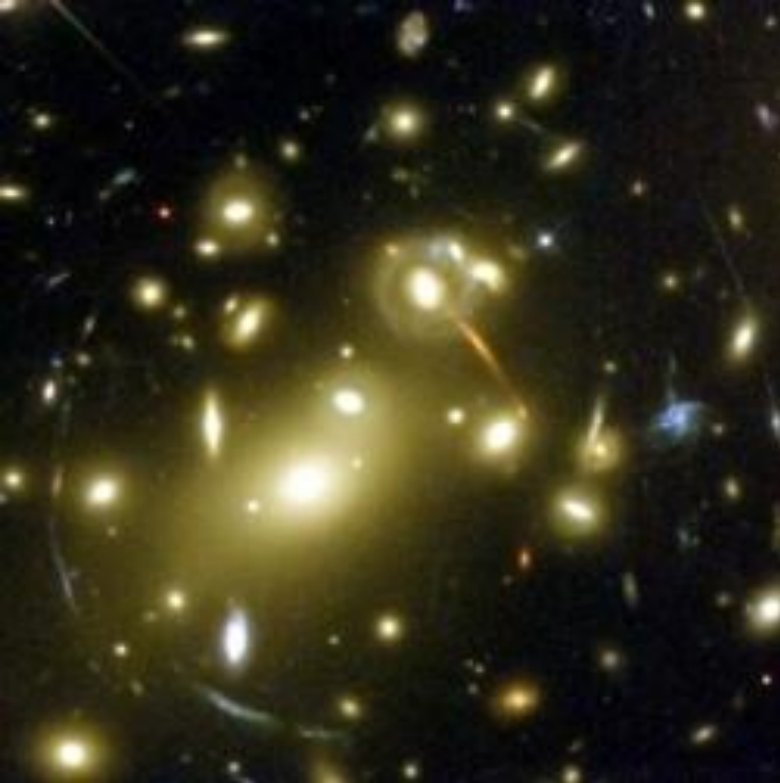
- Μελέτη μαγνητικού πεδίου (μεσοαστρική ύλη, διπλοί αστέρες, πλανήτες)

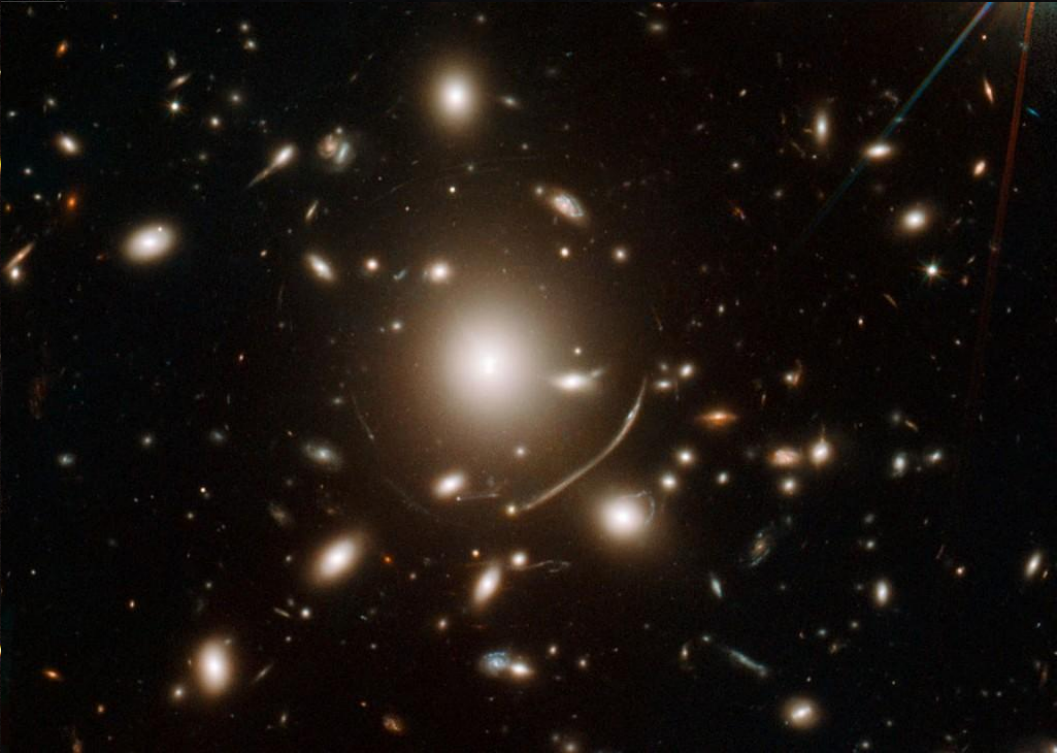
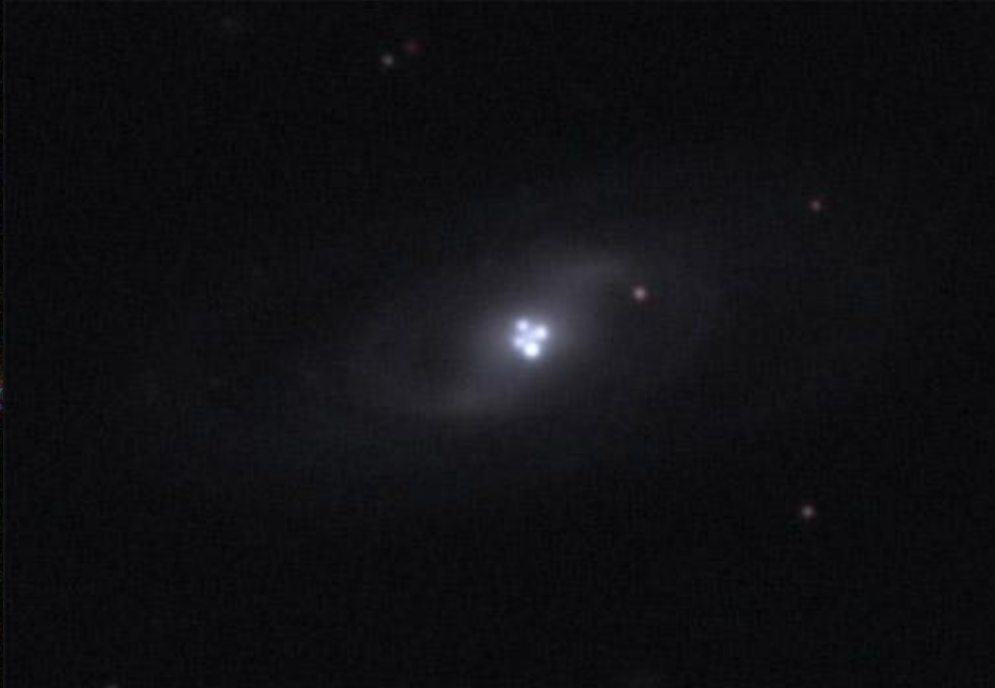
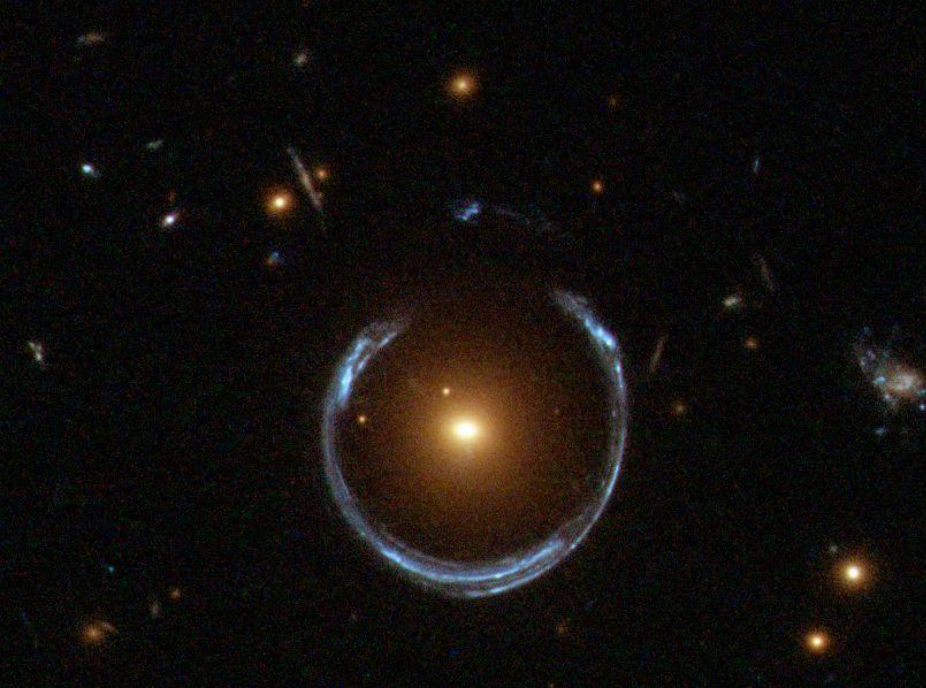
Απεικόνιση- Imaging



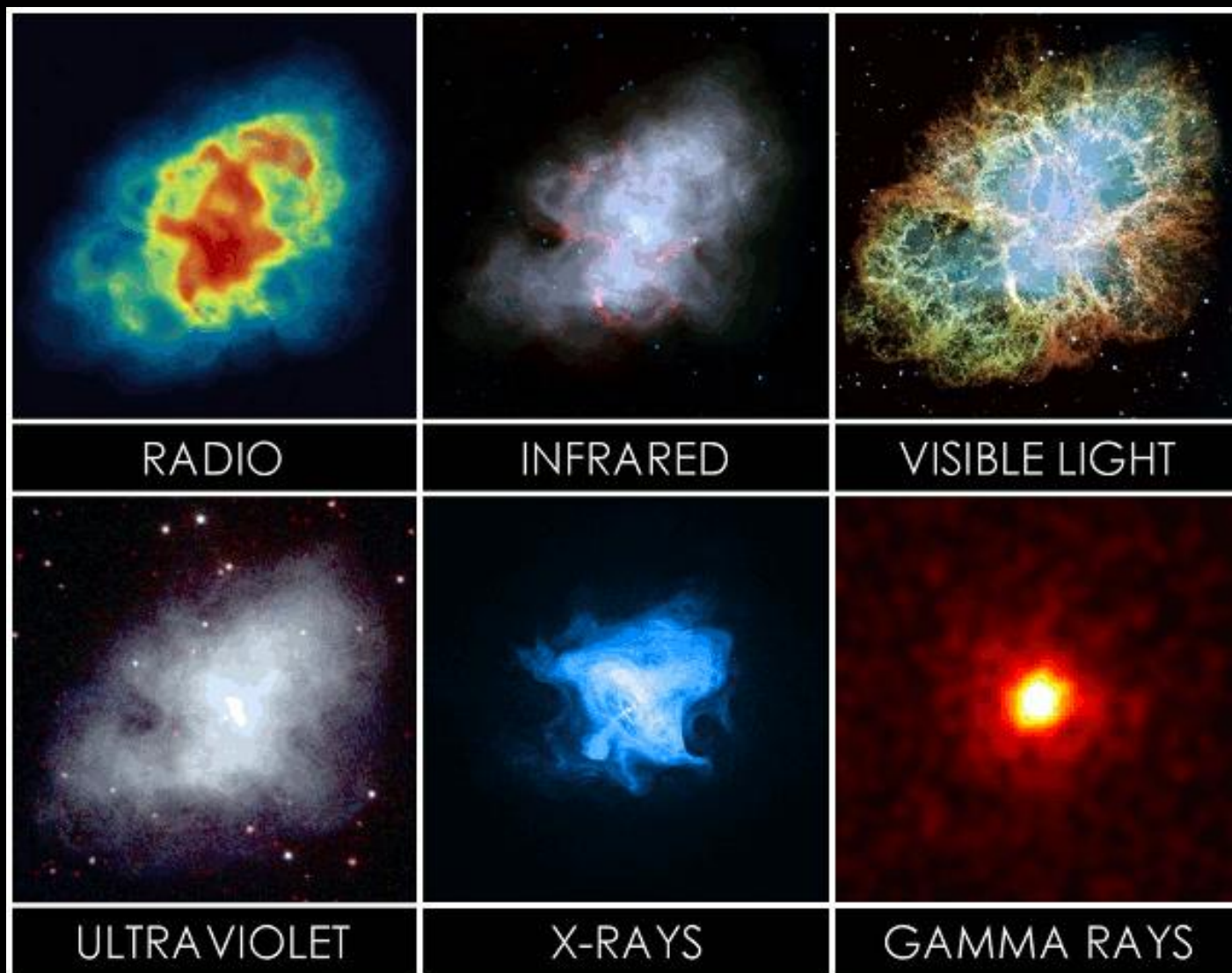
Βαρυτικό φακοί



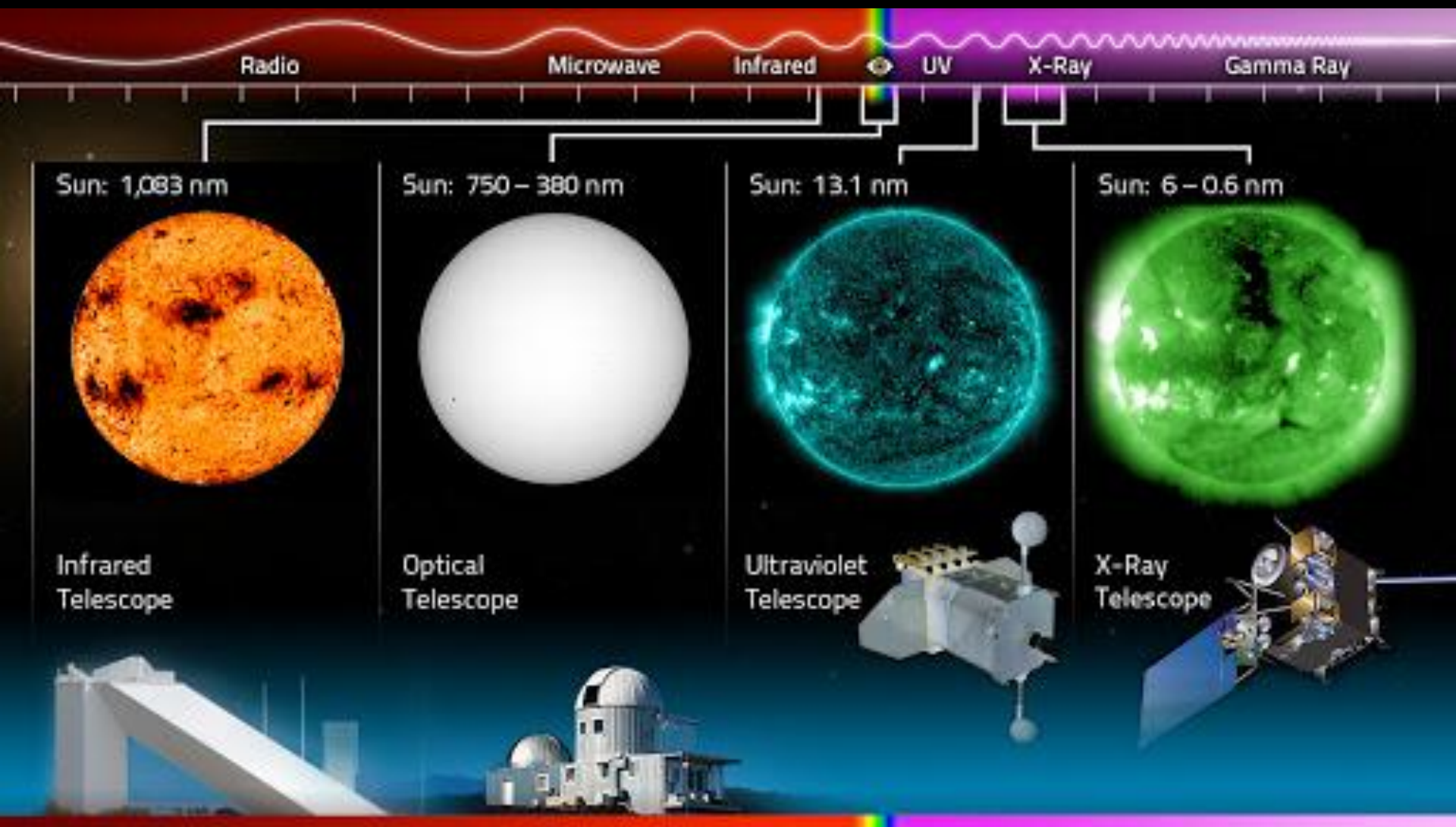




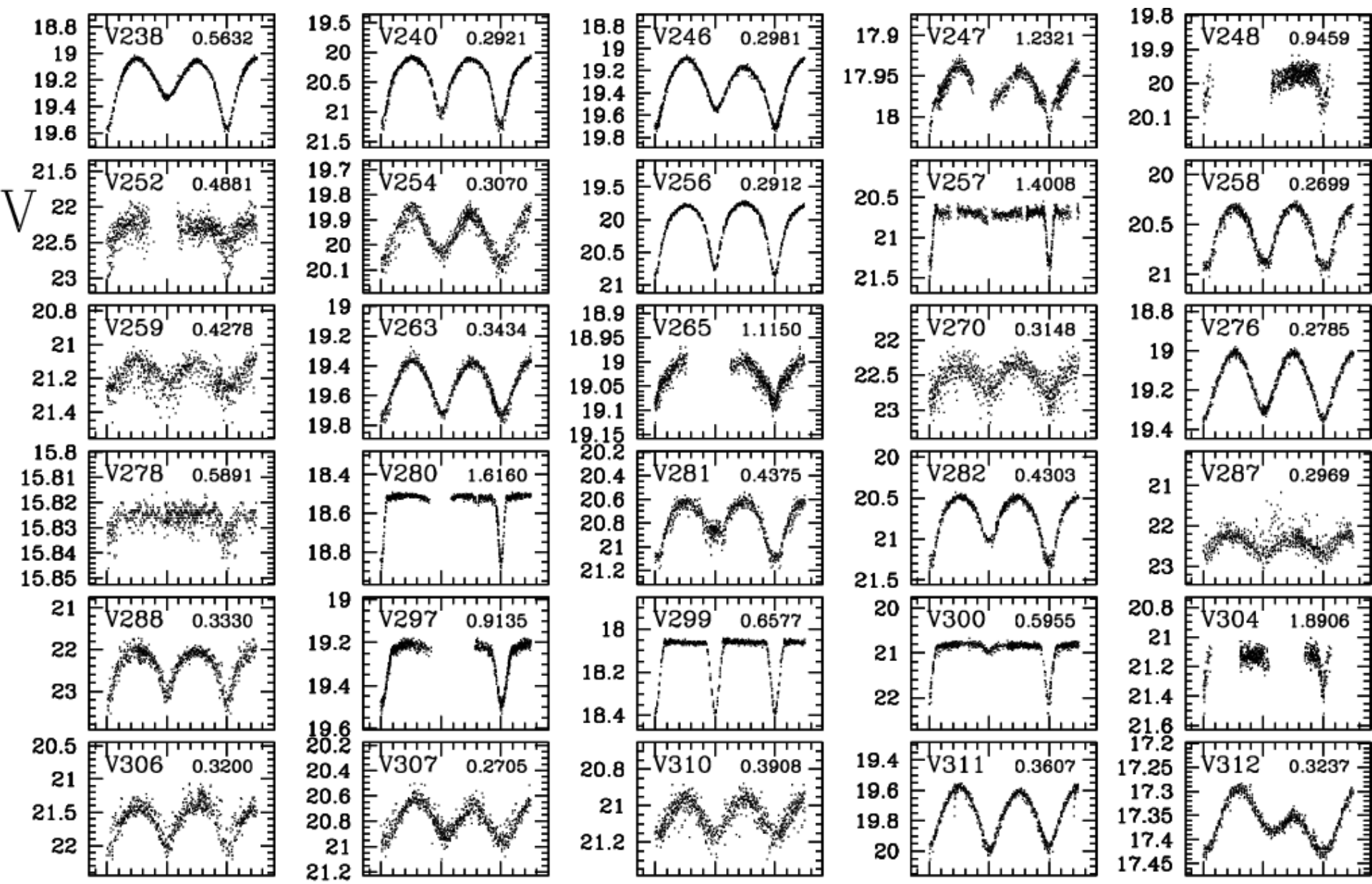
Απεικόνιση σε διάφορα μήκη κύματος



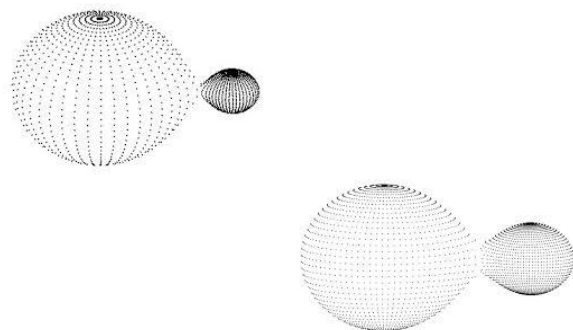
Απεικόνιση σε διάφορα μήκη κύματος



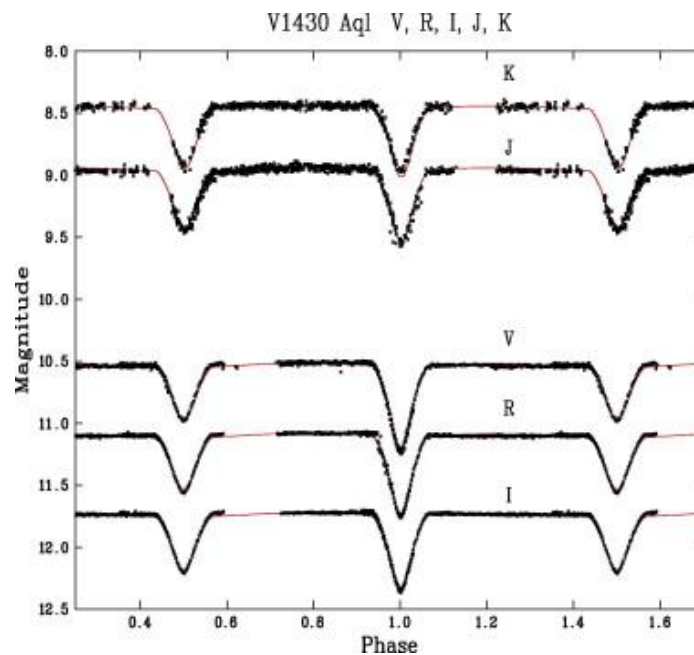
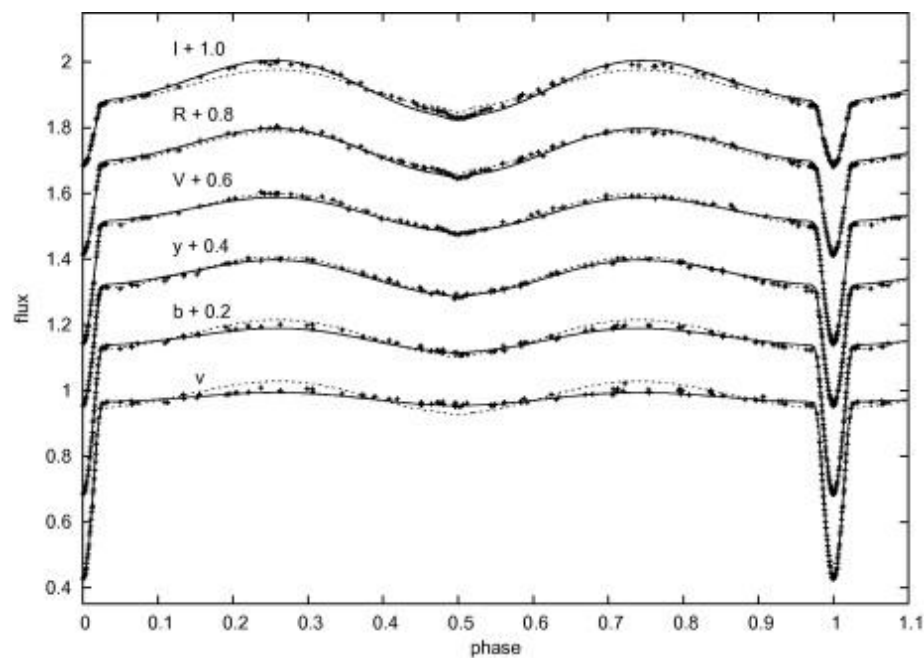
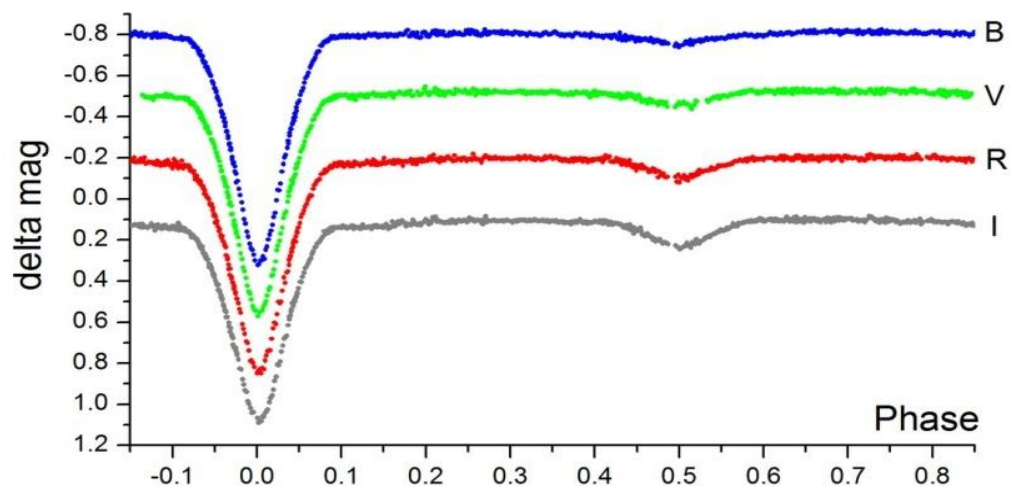
Φωτομετρία - Photometry



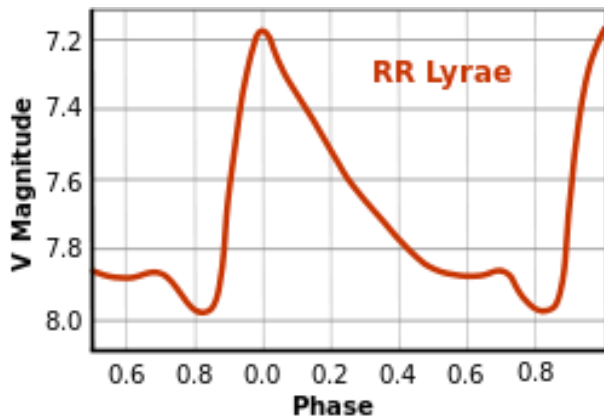
Εκλειπτικοί μεταβλητοί



$$Min.I = HJD\ 2452501.0064 + 1.30575^d E$$

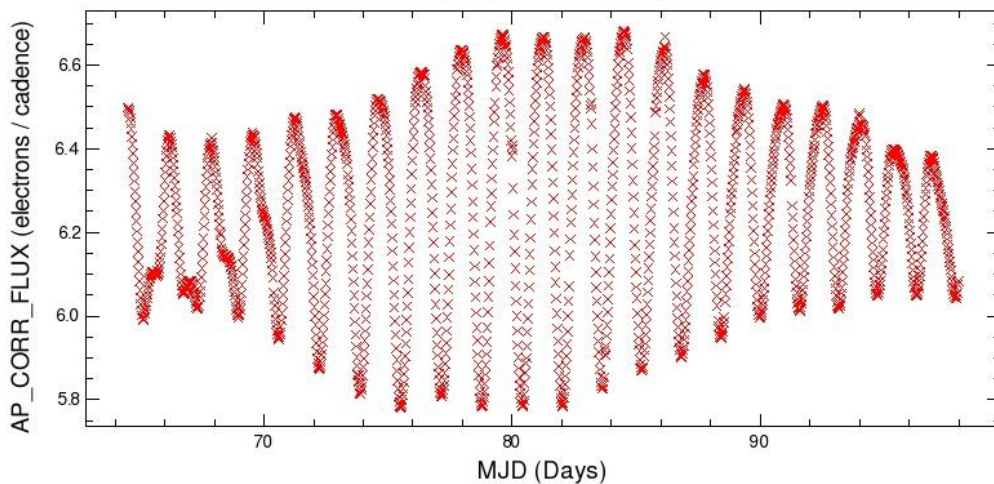


Παλλόμενοι αστέρες



Φαινόμενο Blazhko: περιοδική μεταβολή του πλάτους

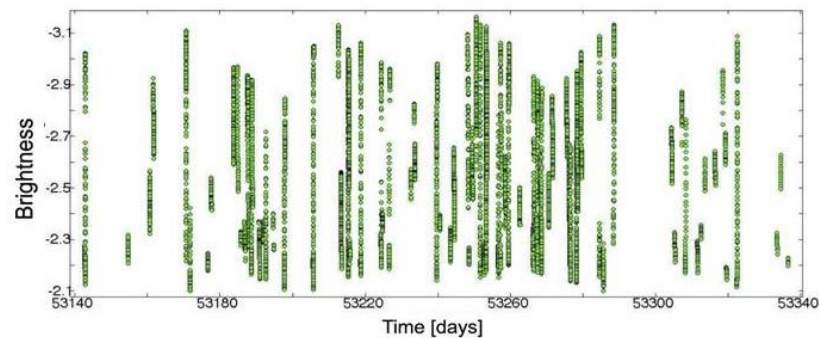
Object Name: 12253350



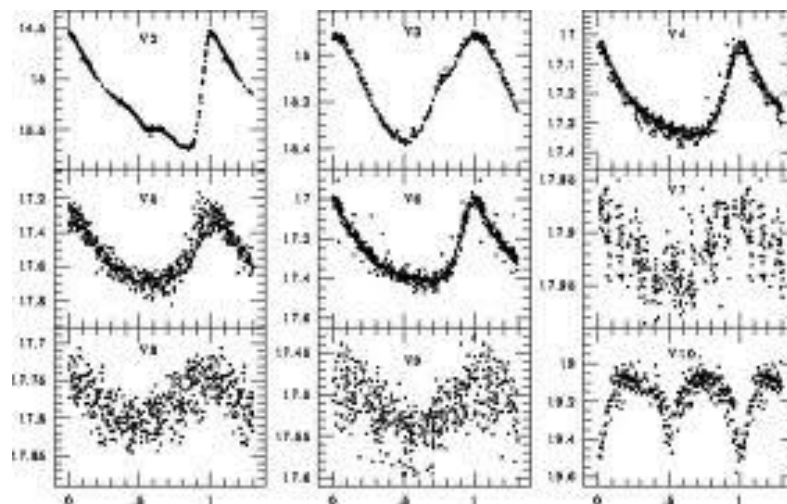
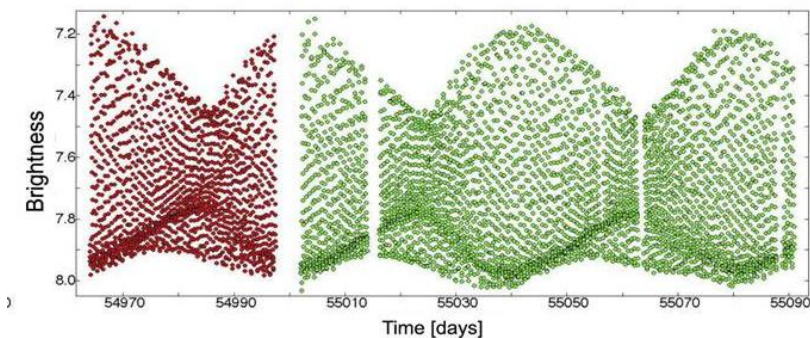
X axis scaling: add 54900

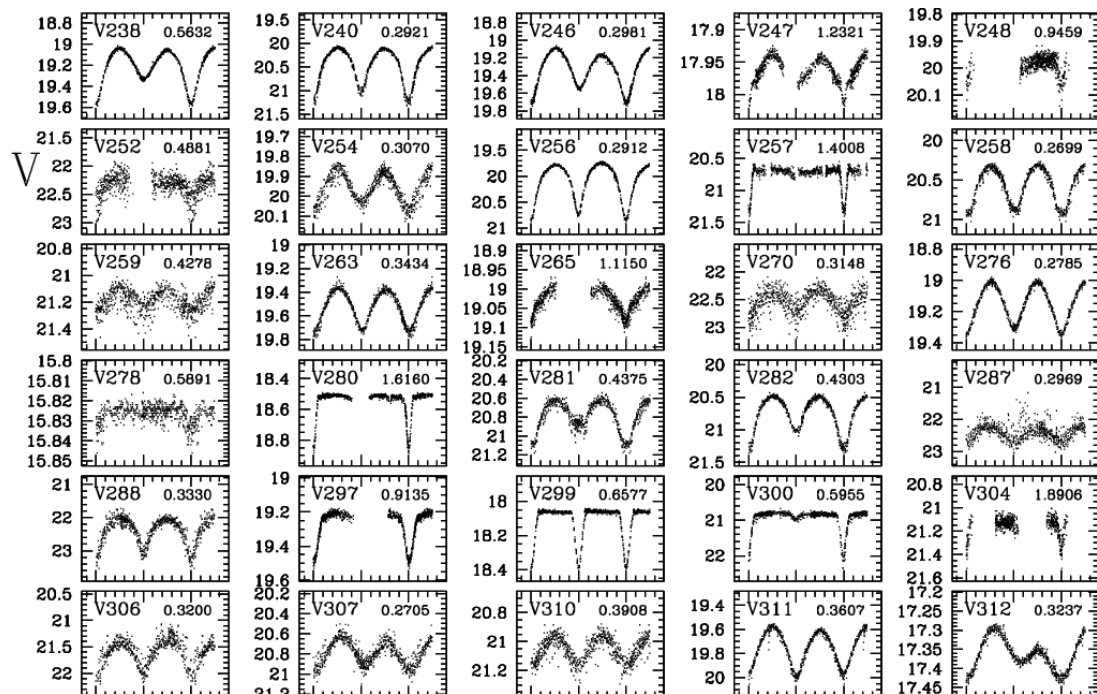
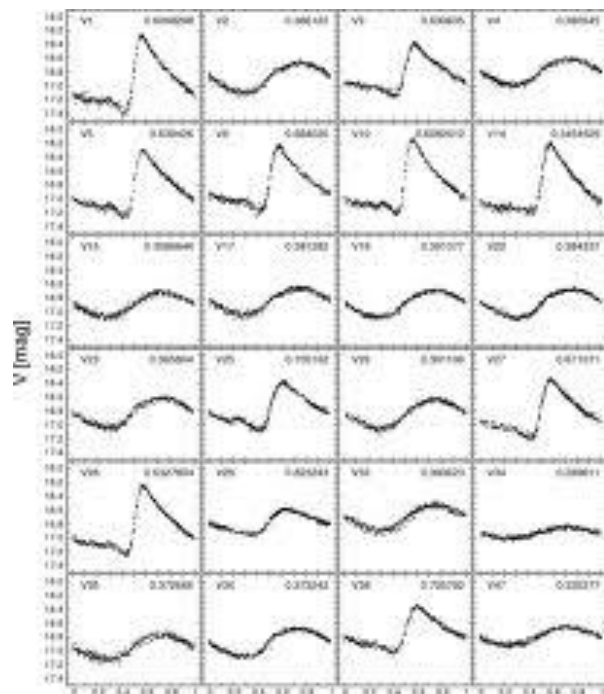
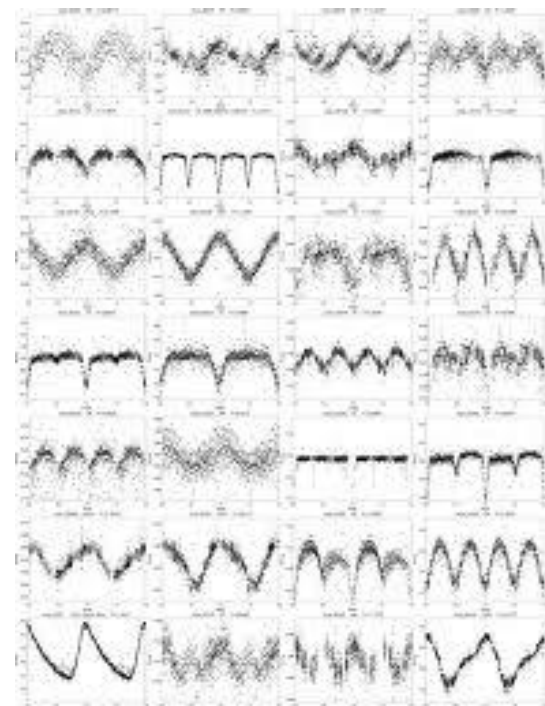
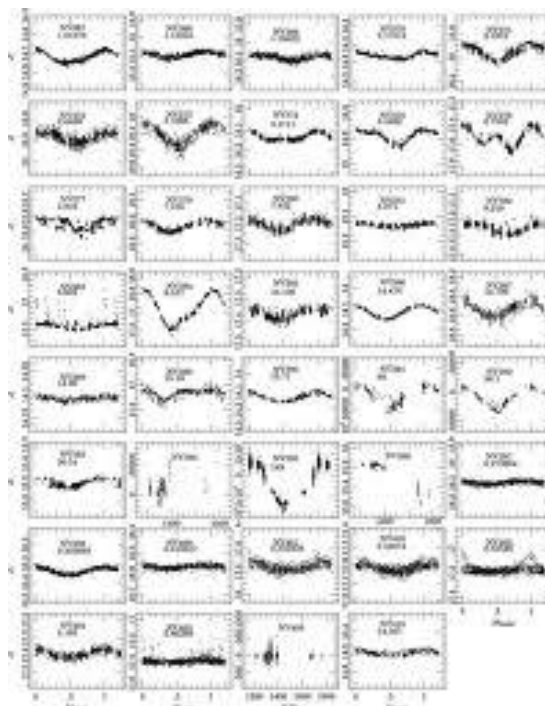
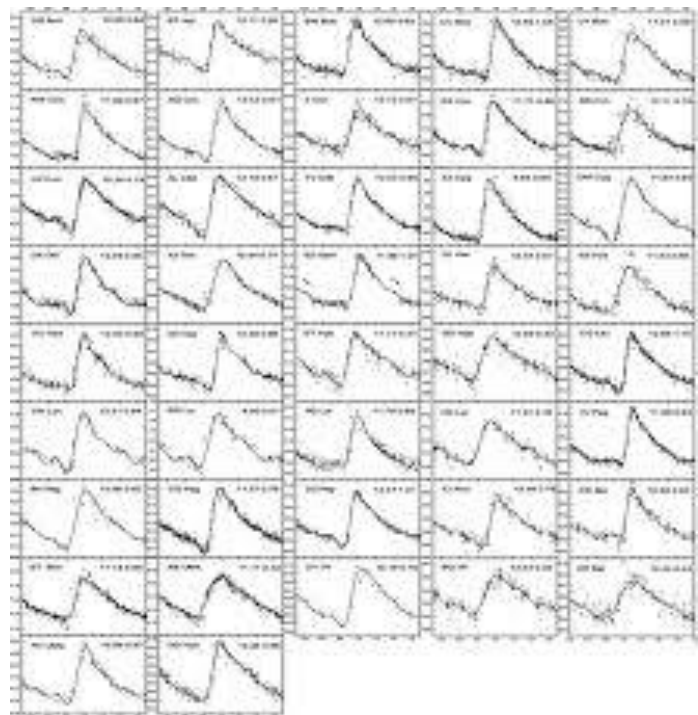
Y axis scaling: multiply by 10^8 and add 1000000000

RR Lyr ground-based data (2004)

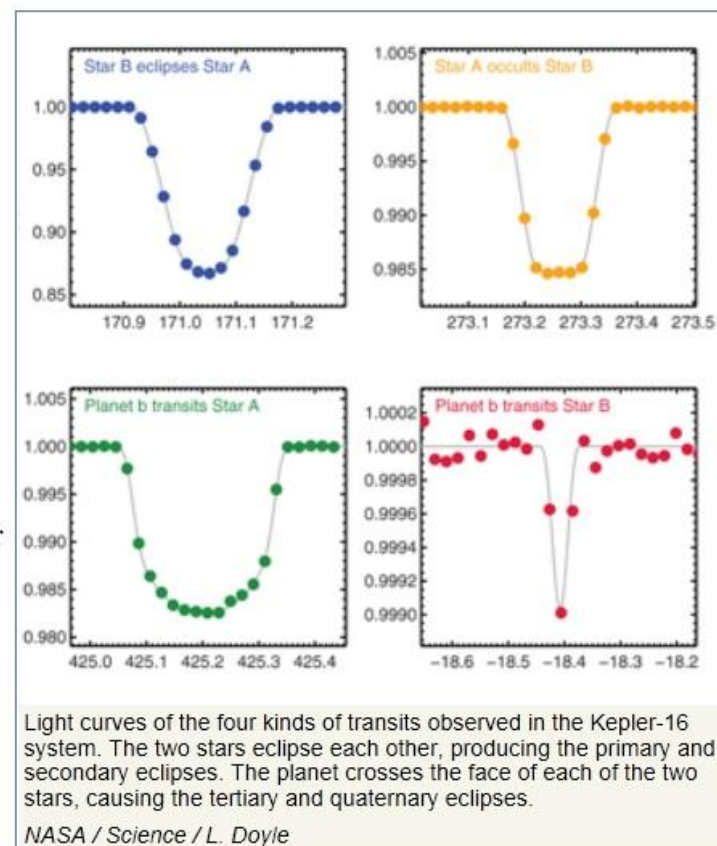
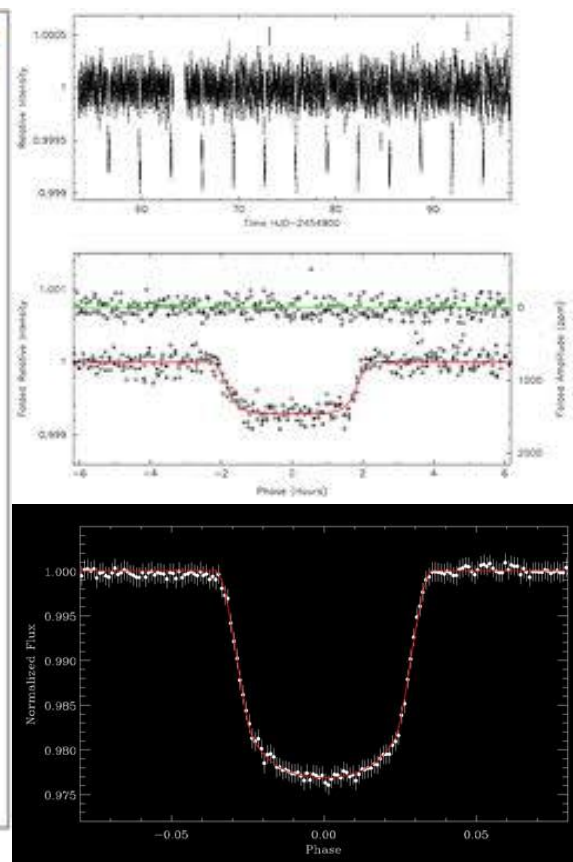
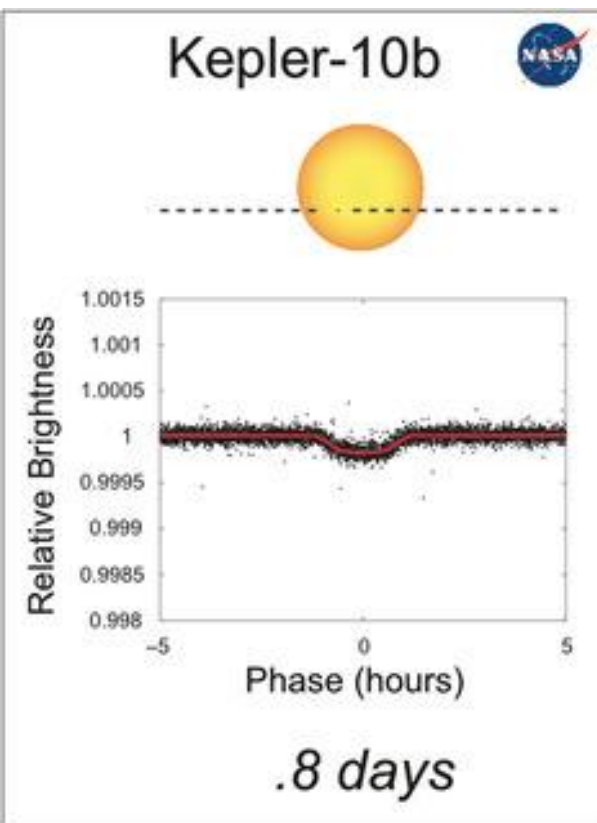


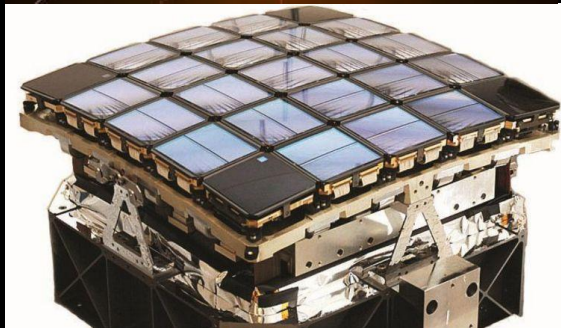
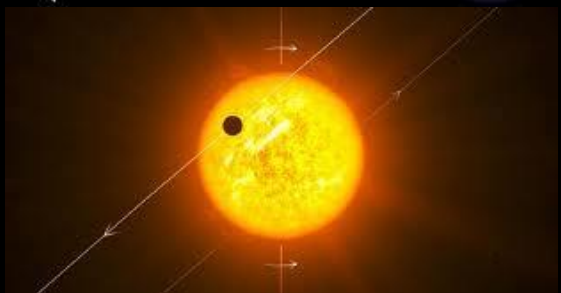
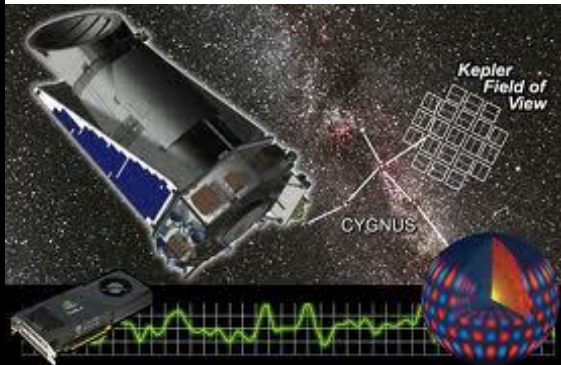
RR Lyr Kepler Q1+Q2 data (2009)



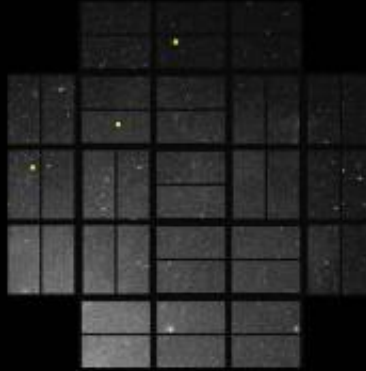


Μελέτη εξωπλανητών

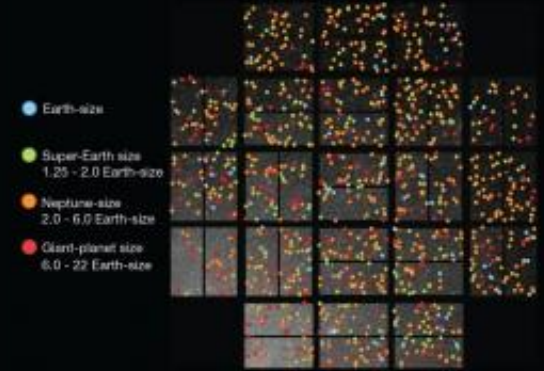




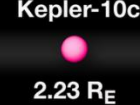
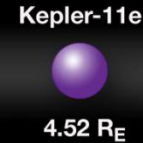
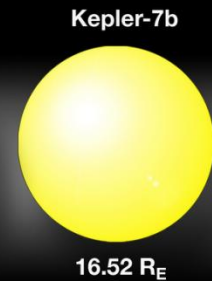
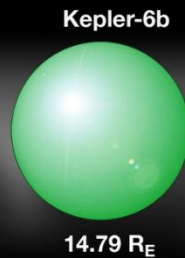
Pre-Kepler Planets in the Field of View



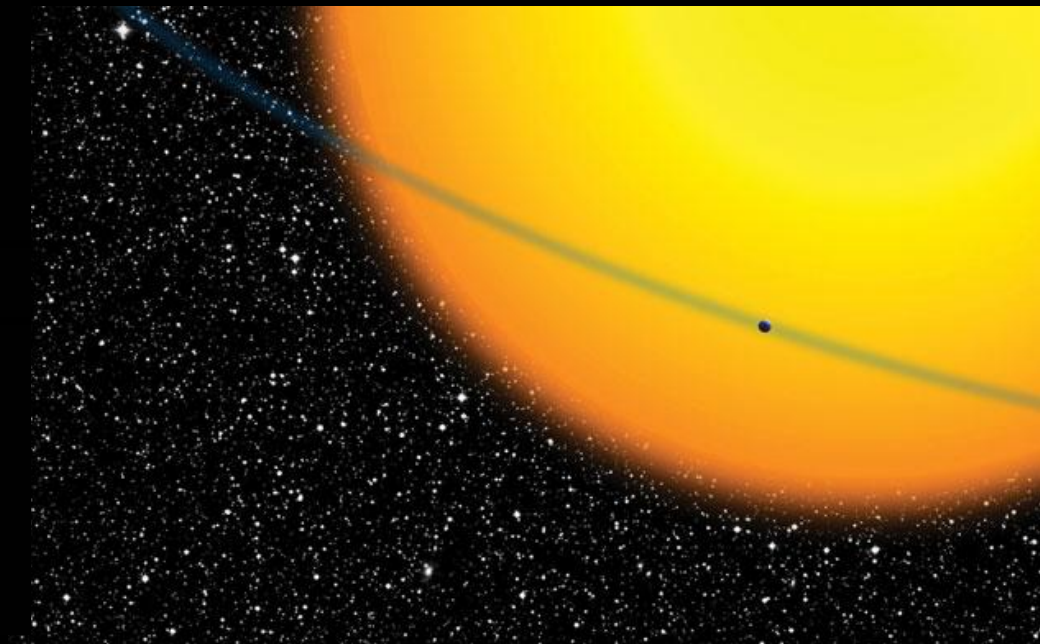
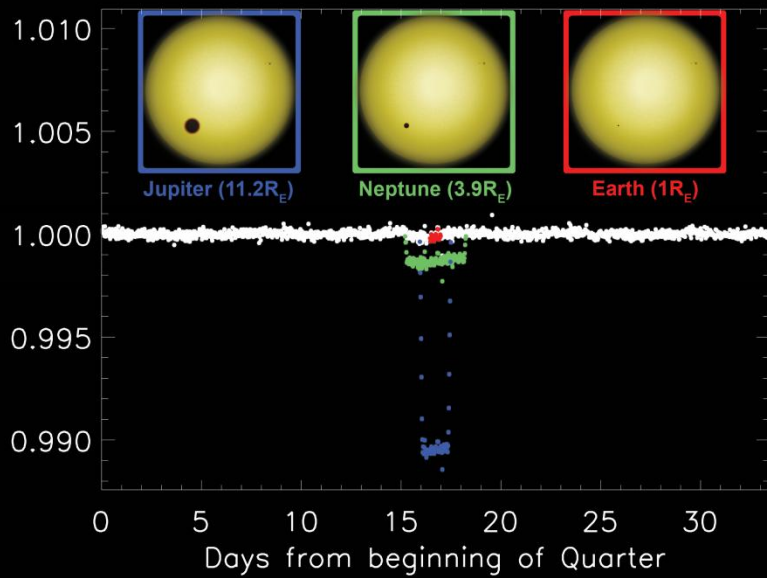
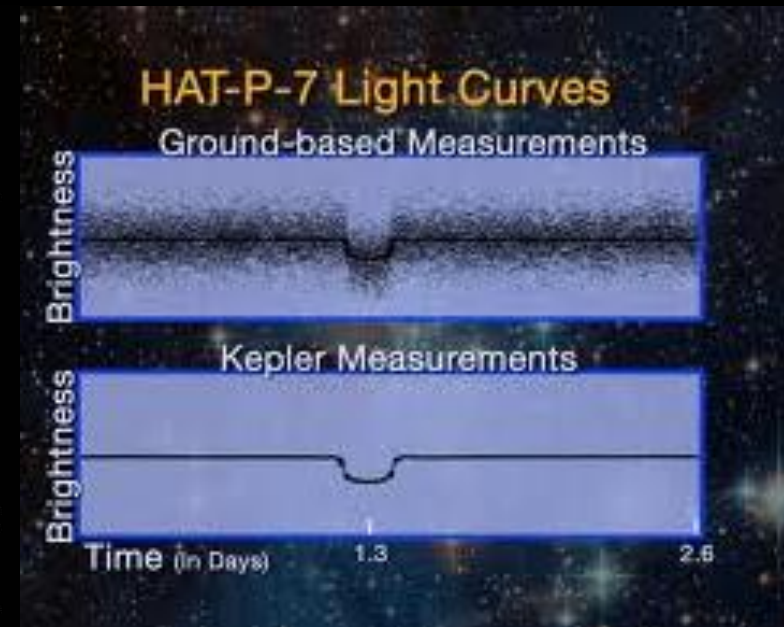
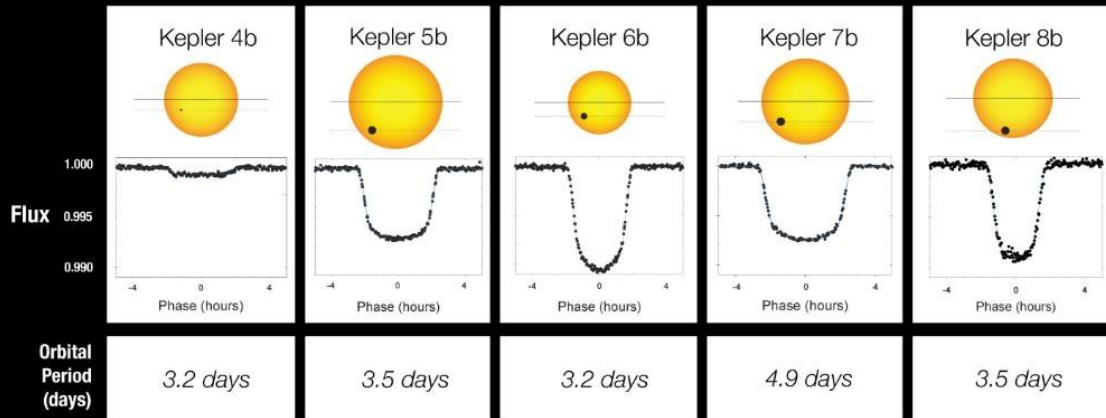
Locations of Kepler Planet Candidates

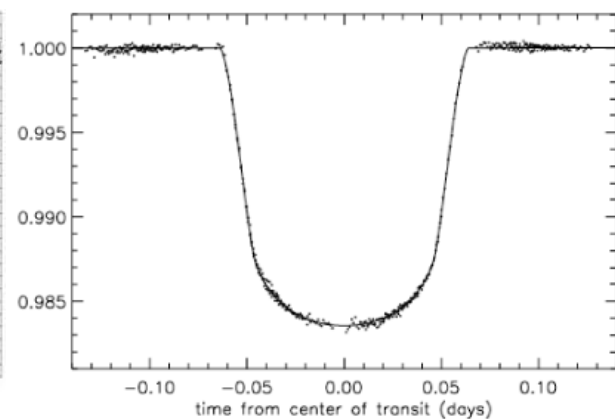
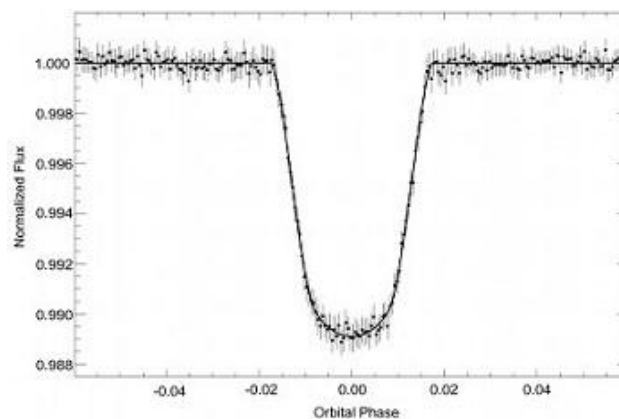
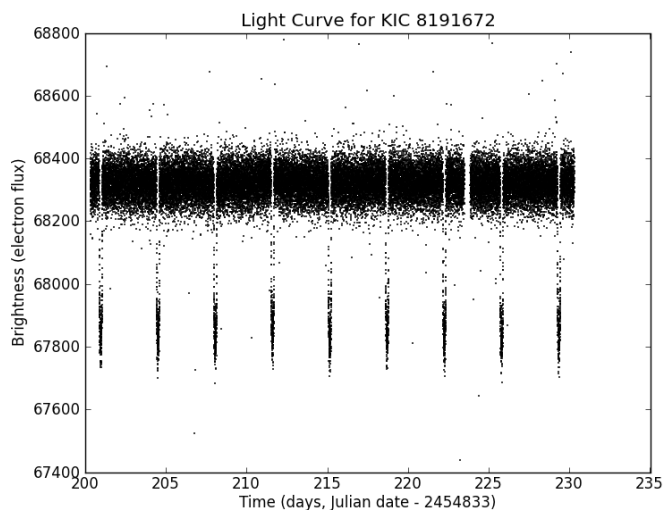
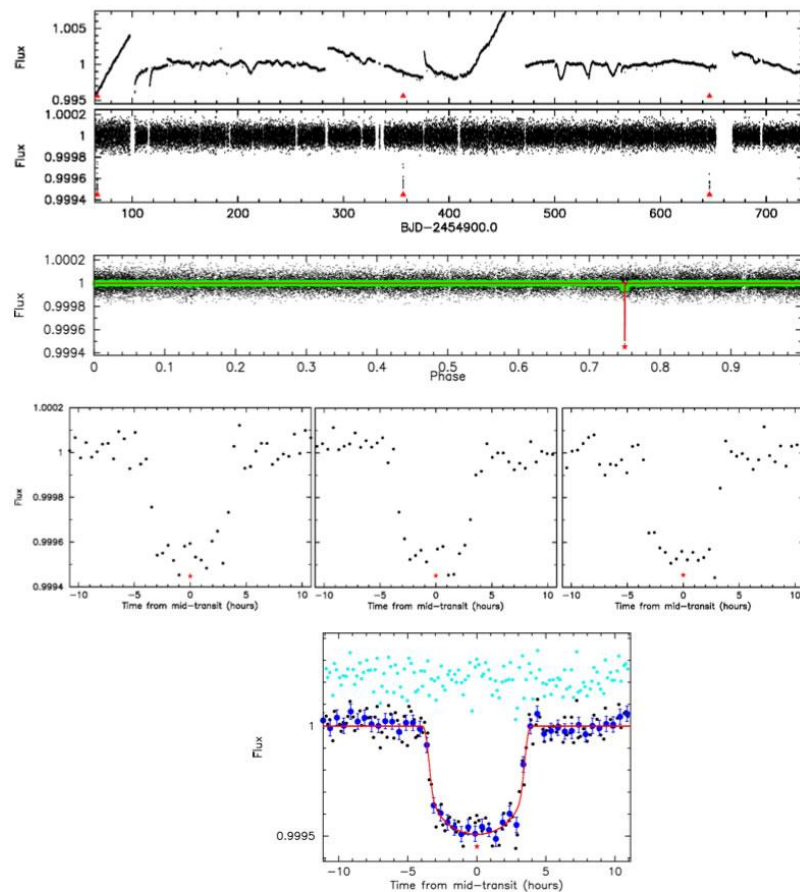
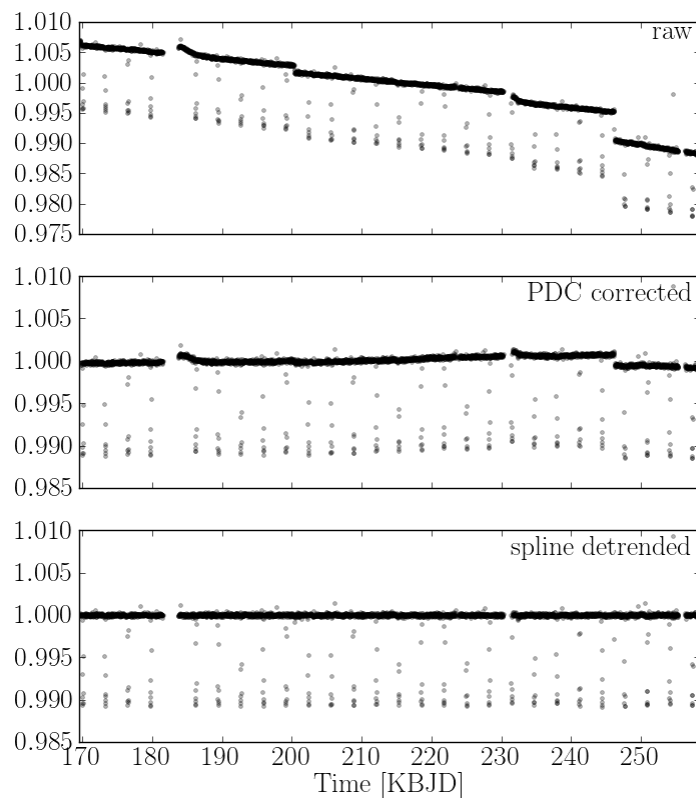


Kepler Planets



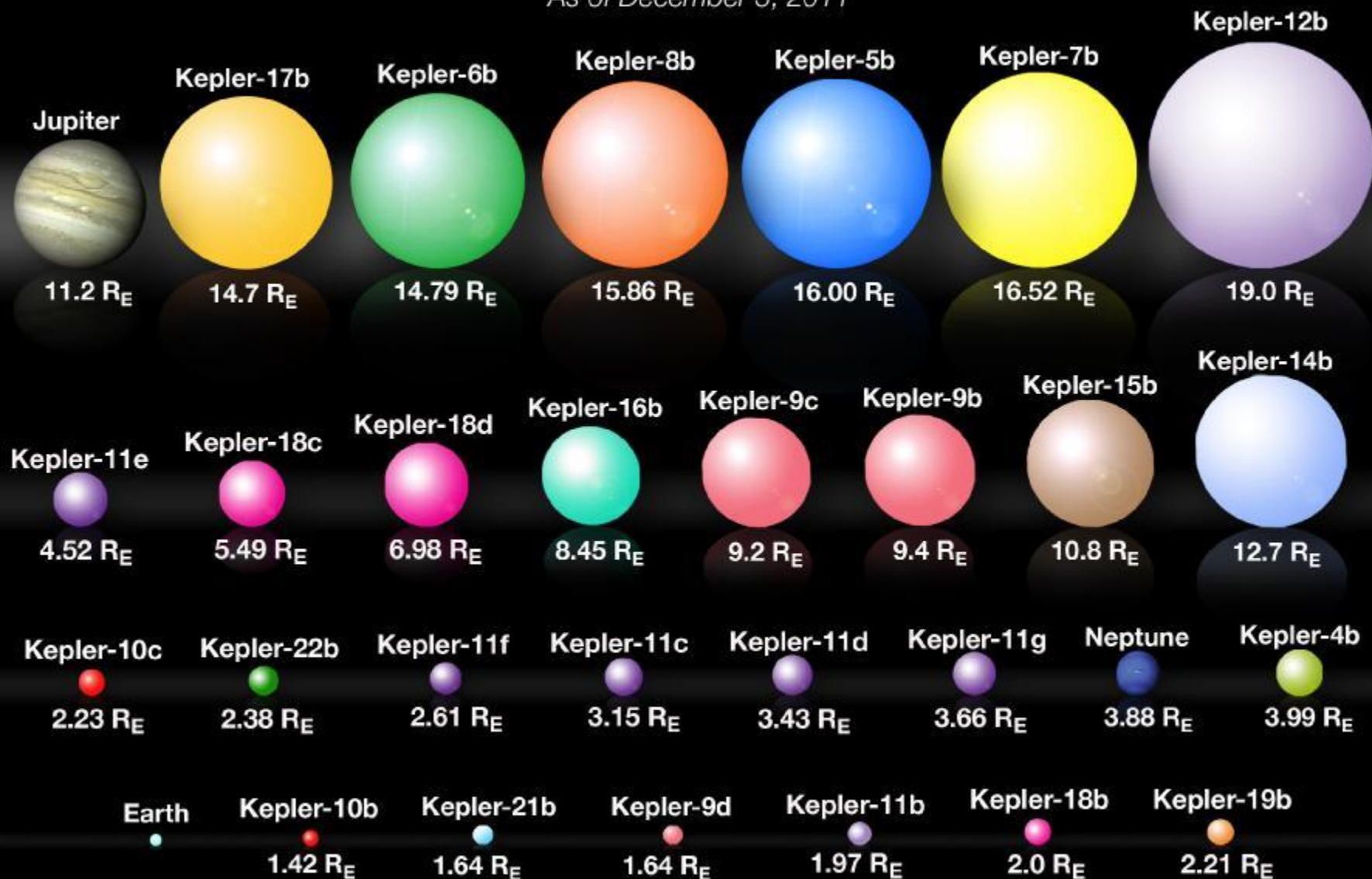
Transit Light Curves





Kepler Planets

As of December 5, 2011



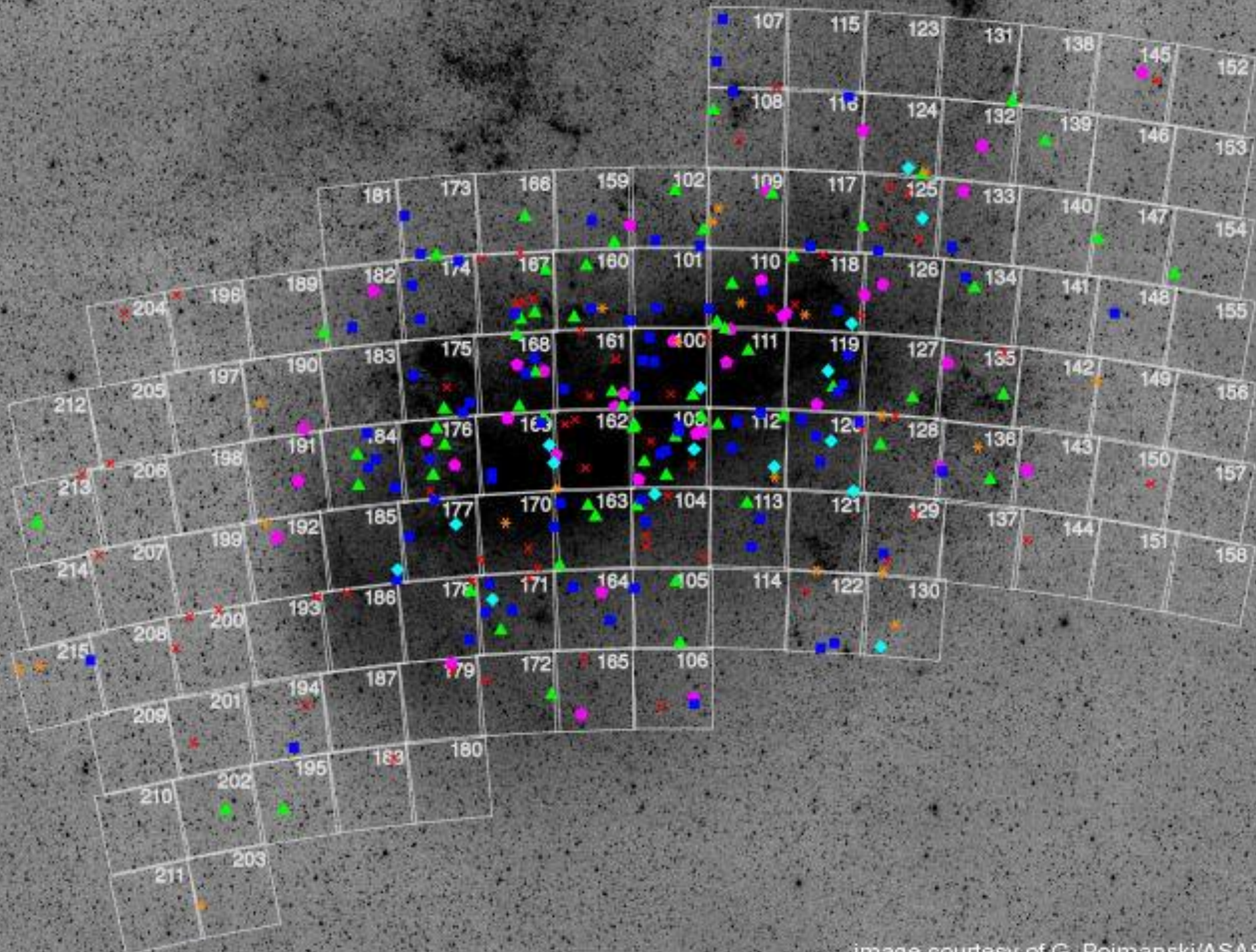
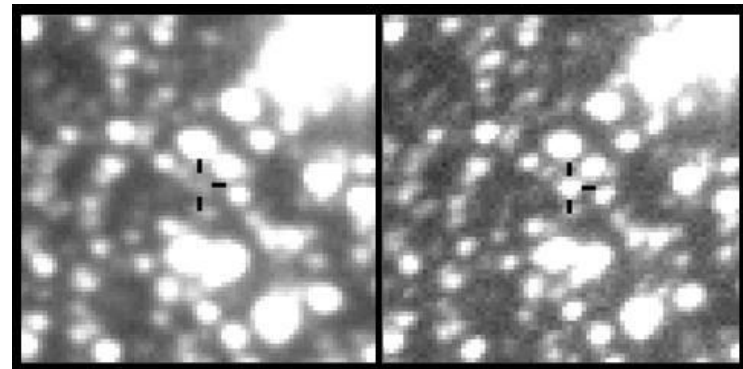
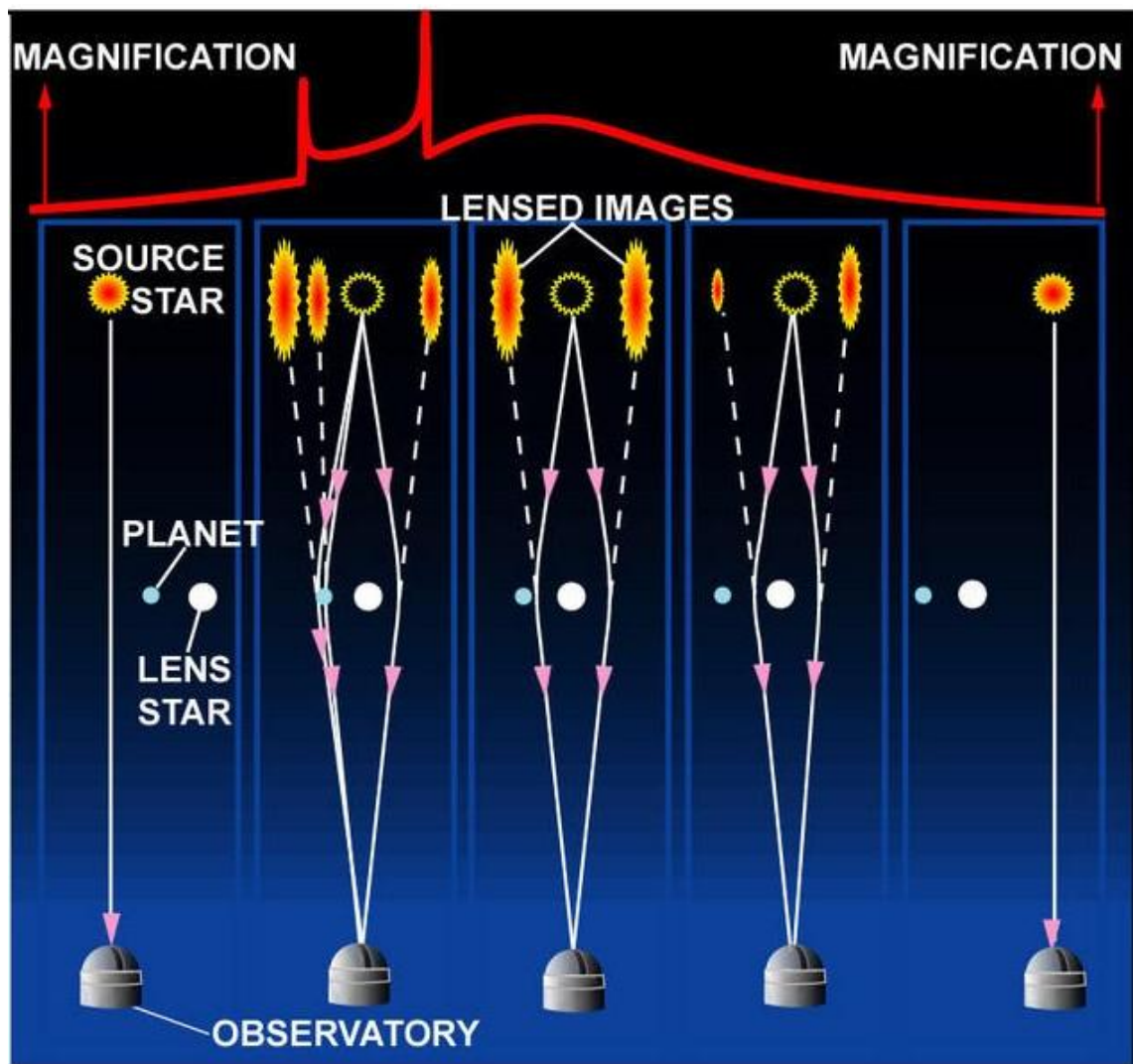
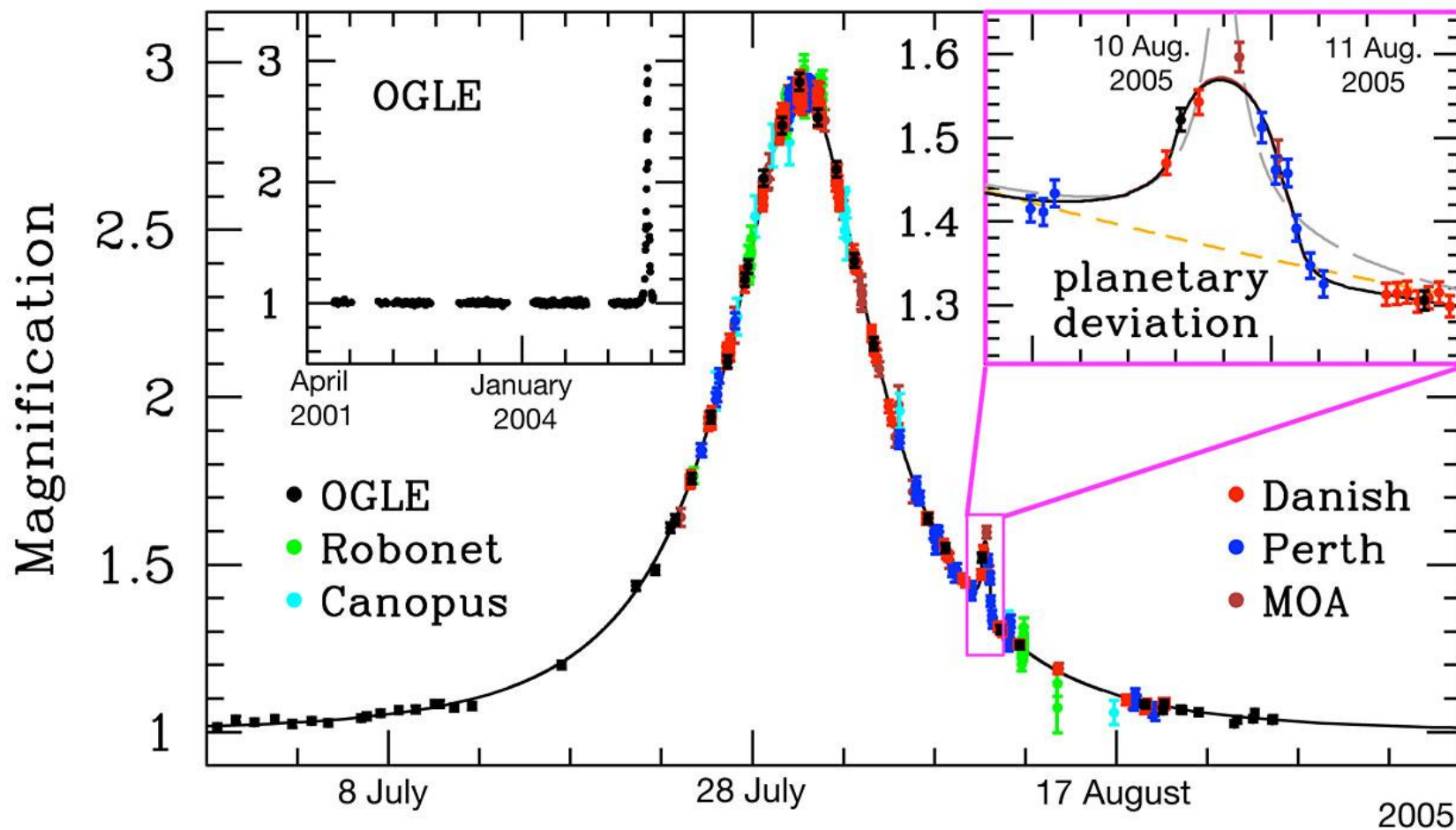


image courtesy of G. Pojmanski/ASAS

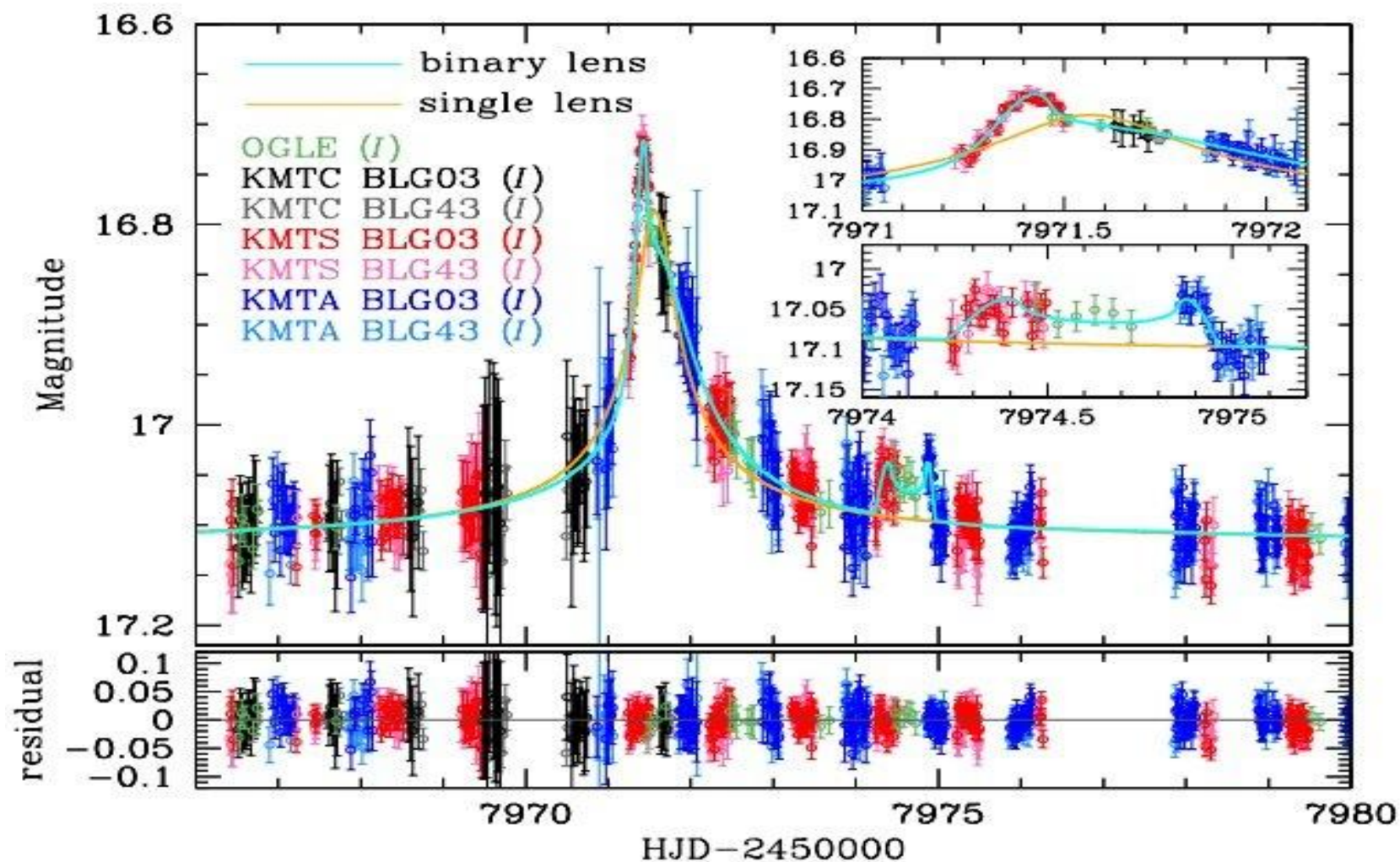
Τεχνική μικροεστίασης (microlensing)



Τεχνική μικροεστίασης (microlensing)

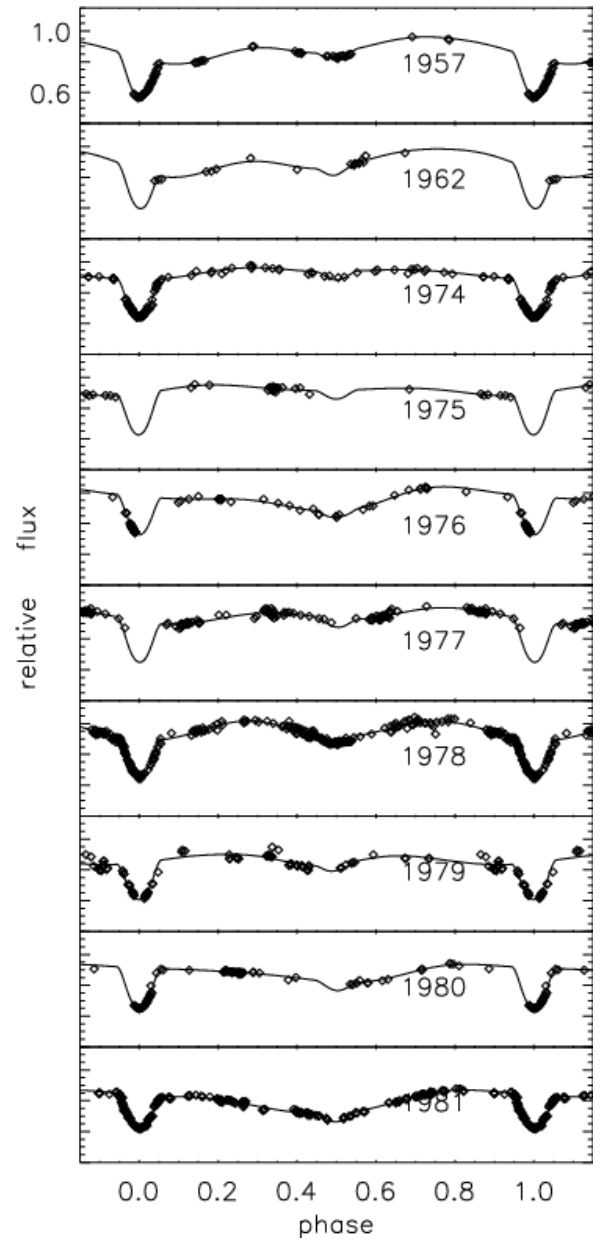
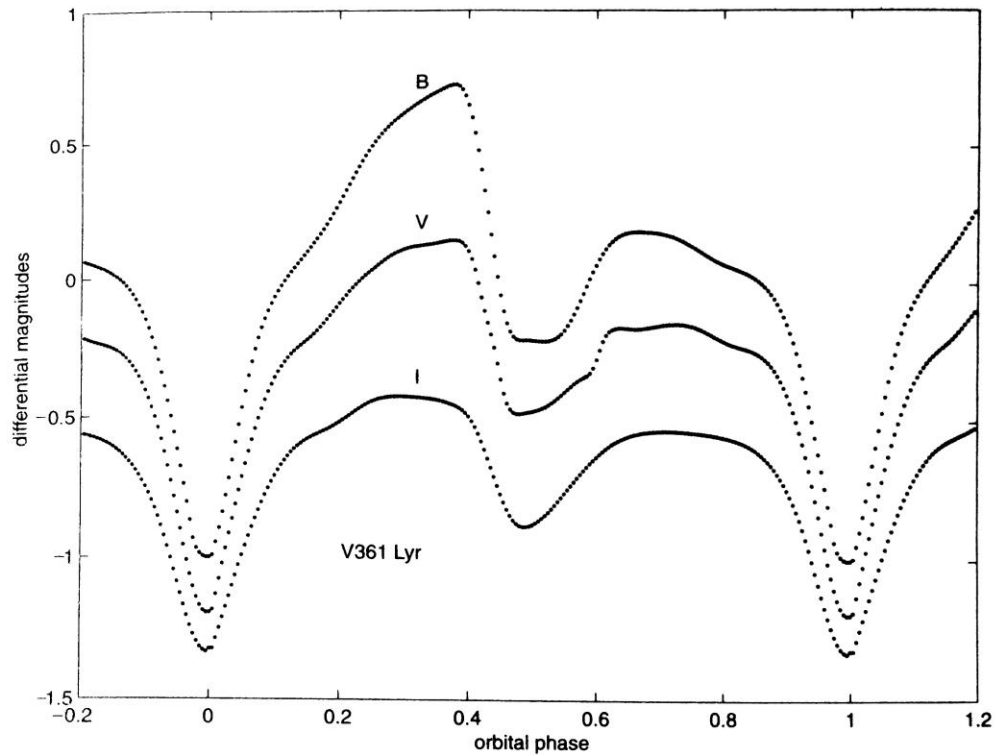


Τεχνική μικροεστίασης (microlensing)



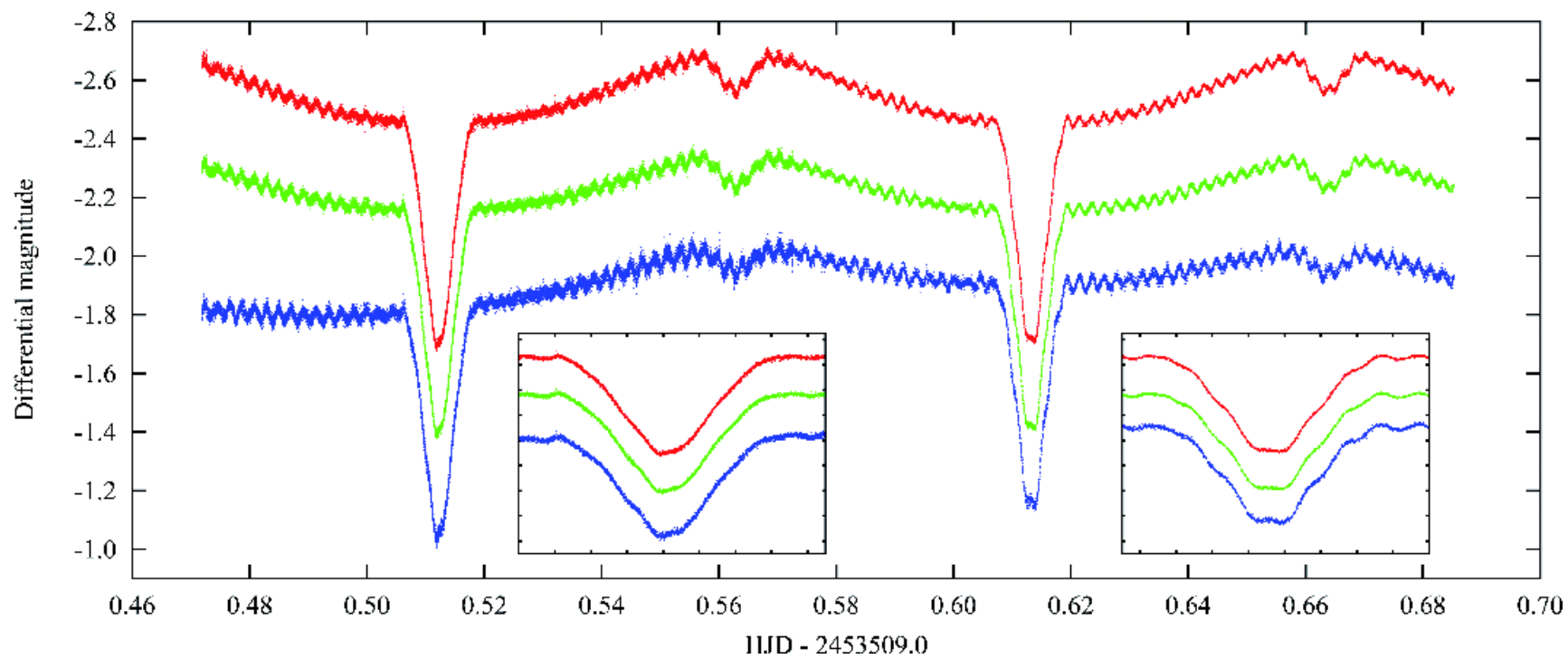
Αστρικές κηλίδες

φωτομετρία (μελέτη μαγνητικού πεδίου)



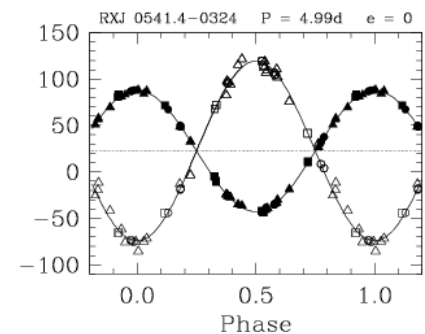
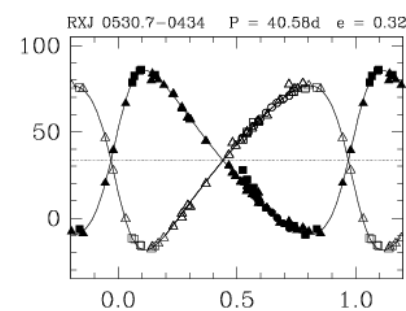
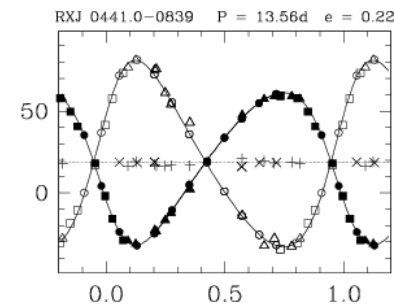
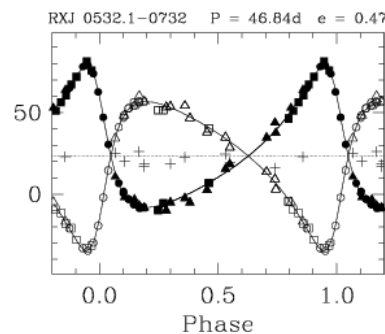
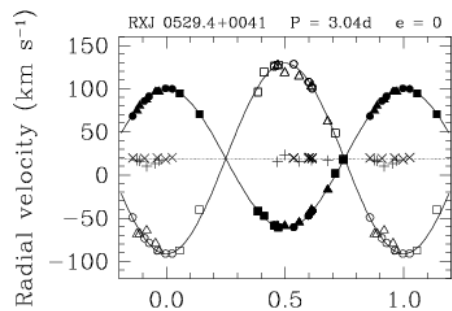
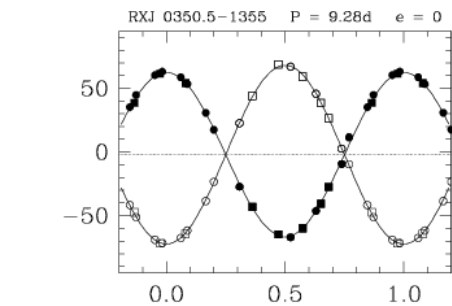
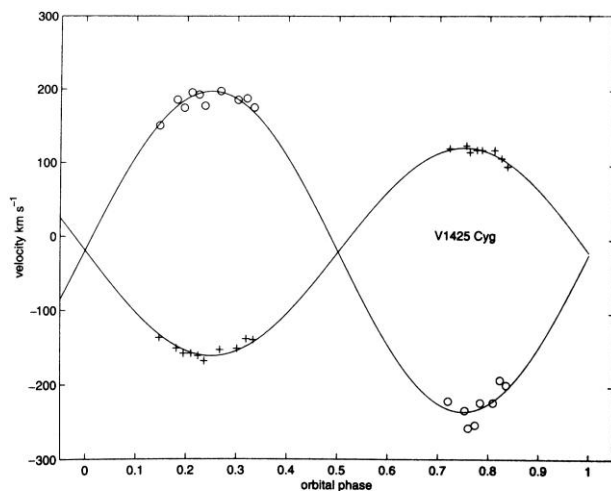
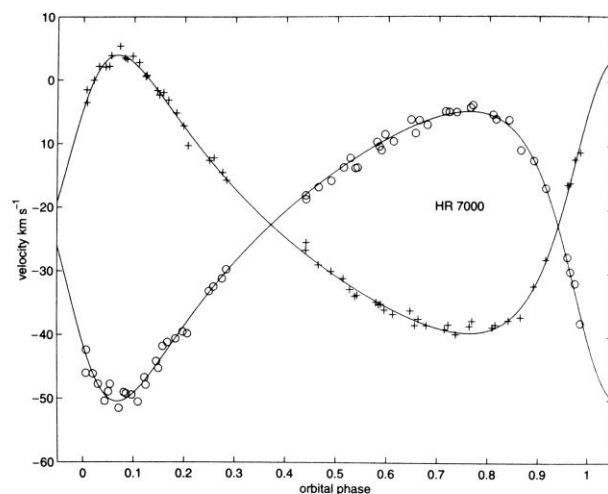
PG 1336-018

(pulsating sdB dwarf)



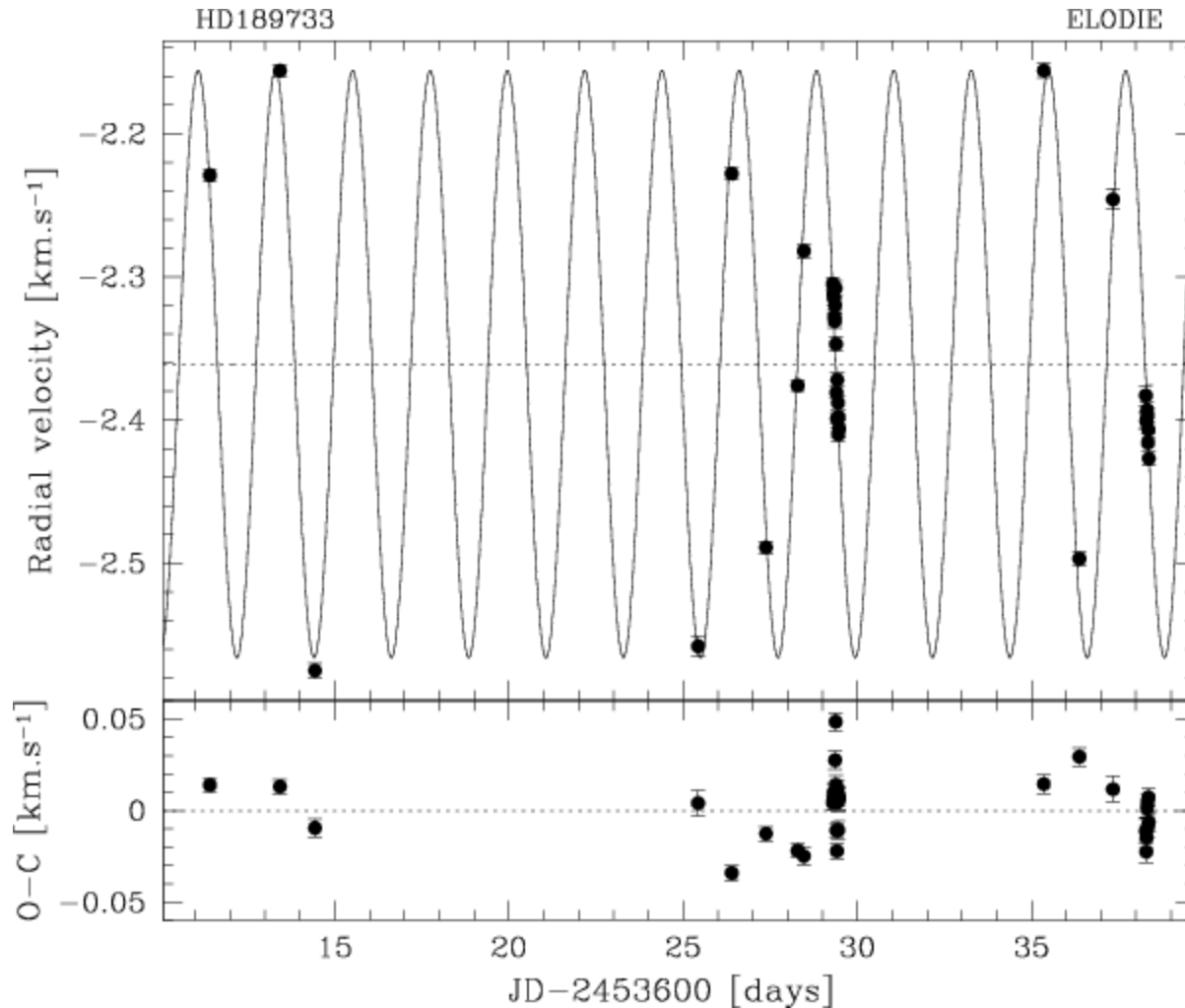
Φασματοσκοπία - Spectroscopy

Μέτρηση ταχυτήτων, προσδιορισμός τροχιών κ.α.



Περιφορά πλανητών γύρω από αστέρια

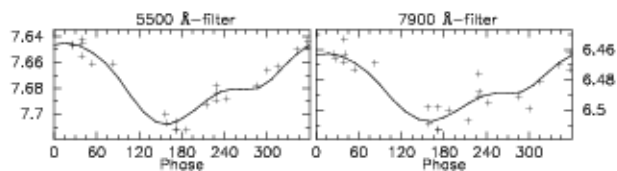
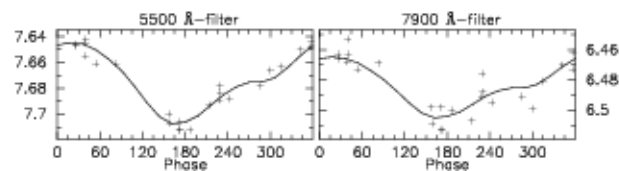
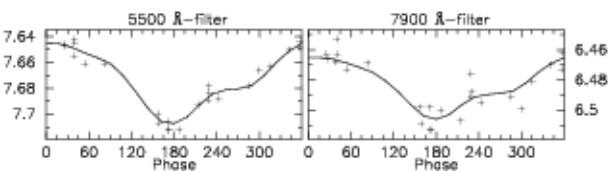
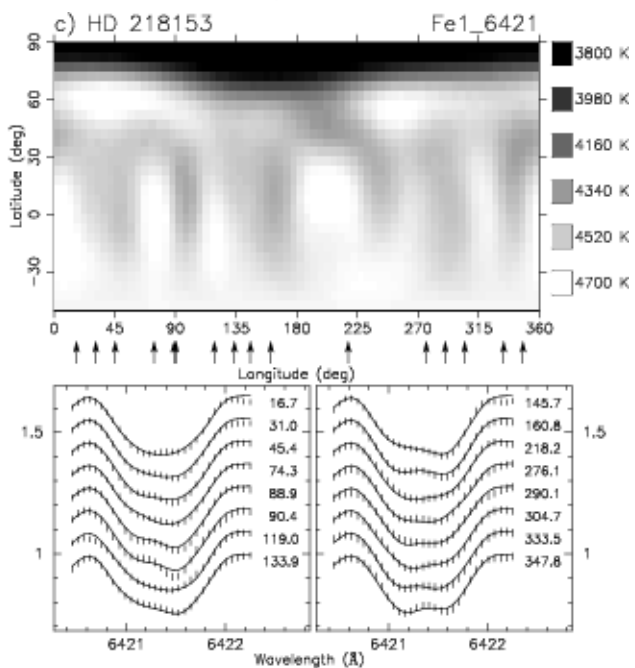
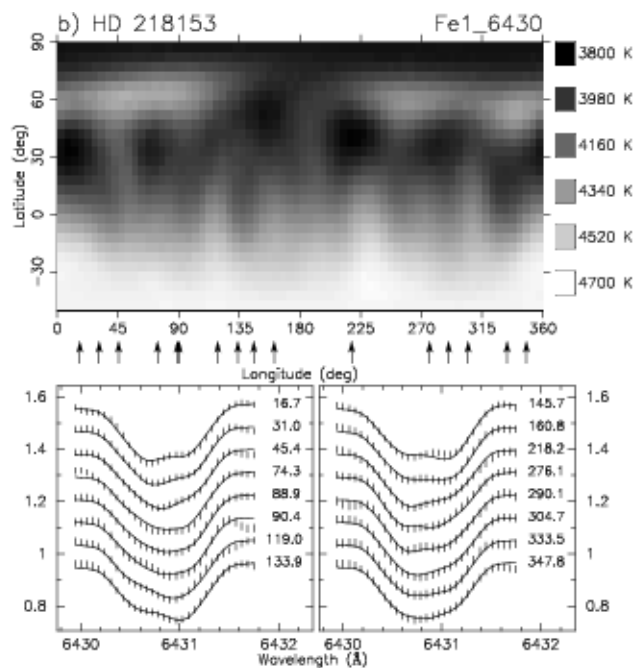
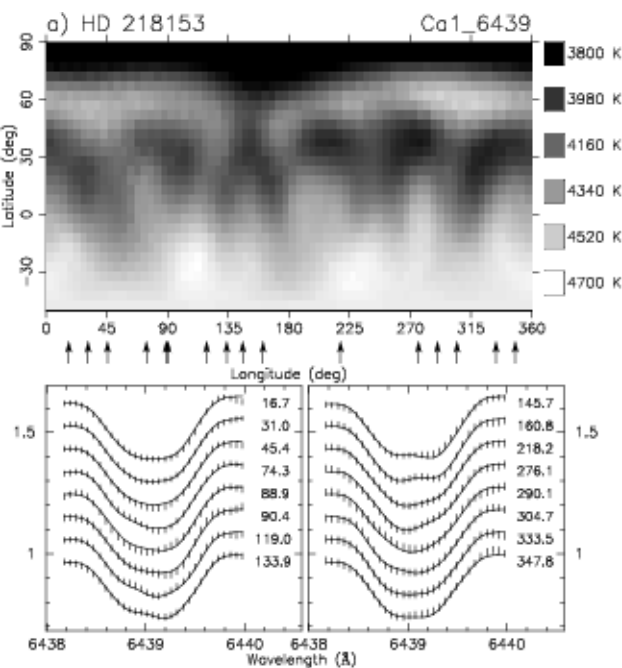
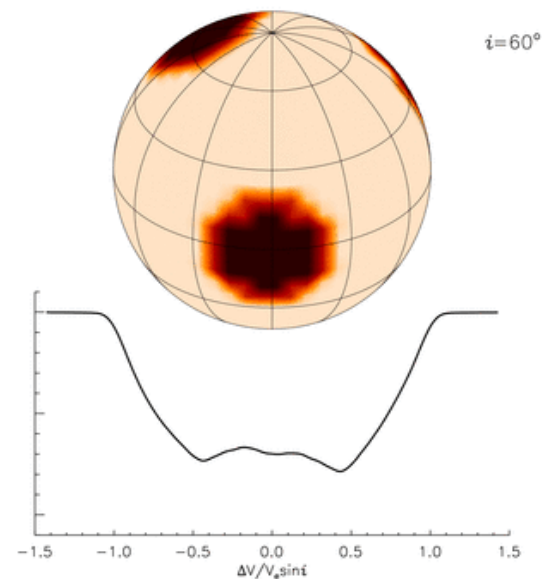
φασματοσκοπία
(μέτρηση μάζας)



Αστρικές κηλίδες

φασματοσκοπία

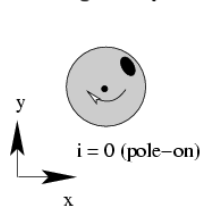
(μελέτη μαγνητικού πεδίου)



Αστρικές κηλίδες

φασματοσκοπία (μελέτη μαγνητικού πεδίου)

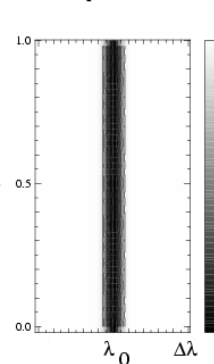
Star geometry



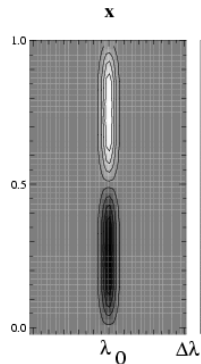
ϕ



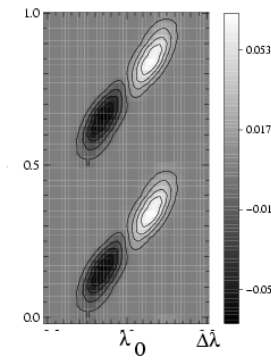
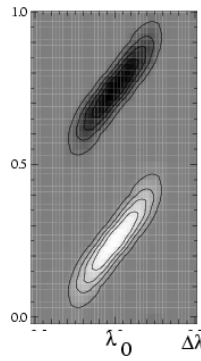
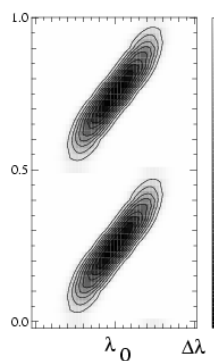
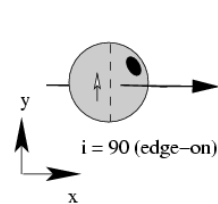
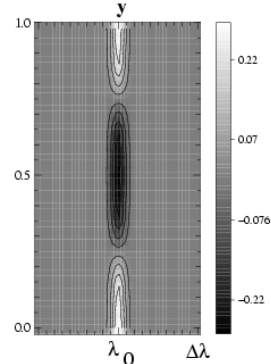
Spectrum



x



Photocenters

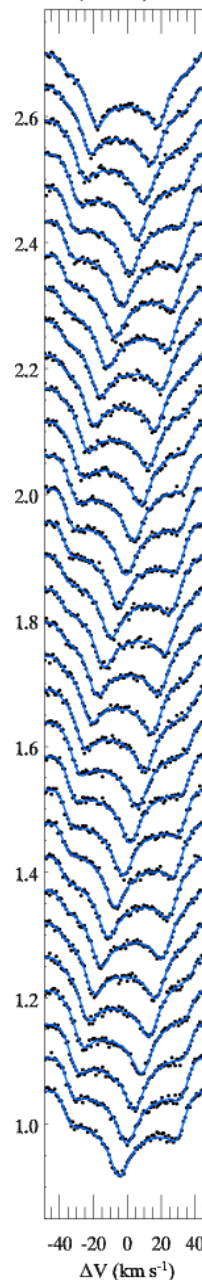


(a)

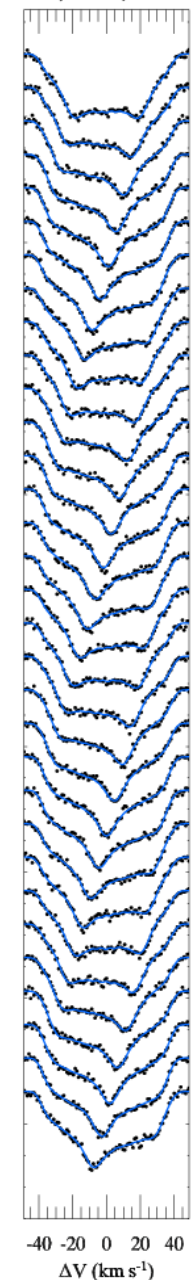
(b)

(c)

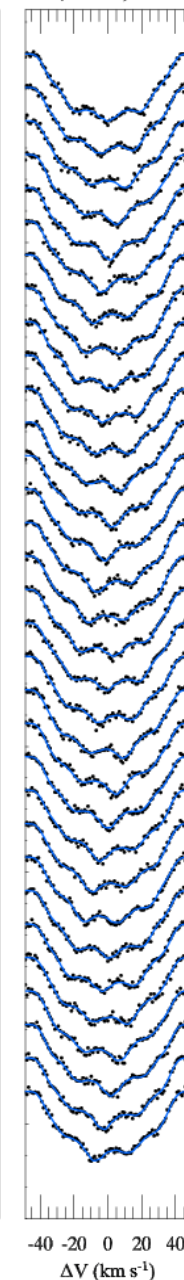
$l=6, m=6, i=60^\circ$



$l=6, m=5, i=60^\circ$

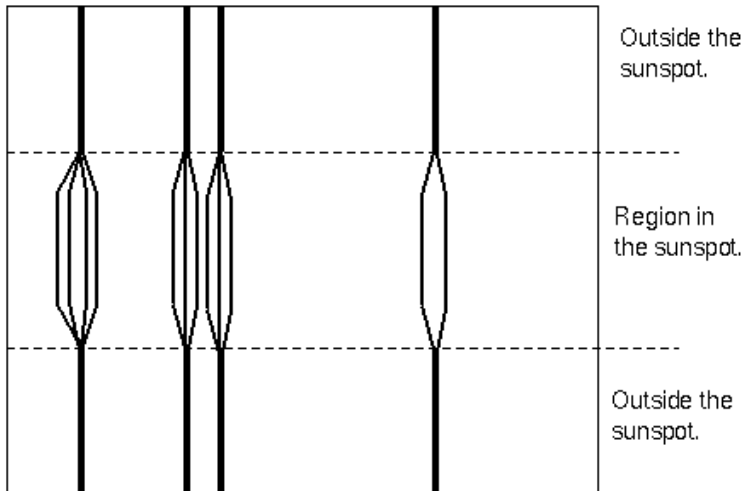


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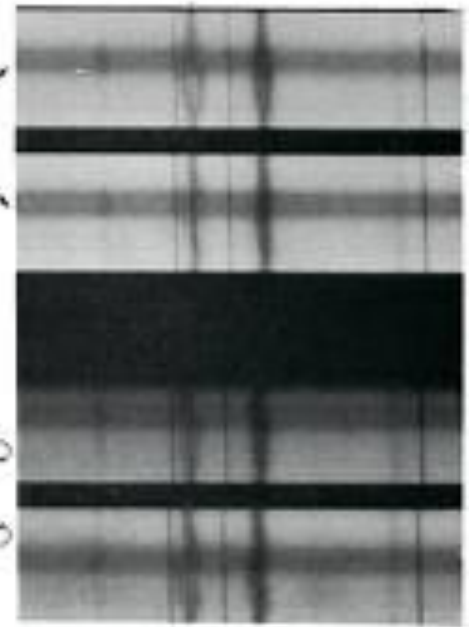
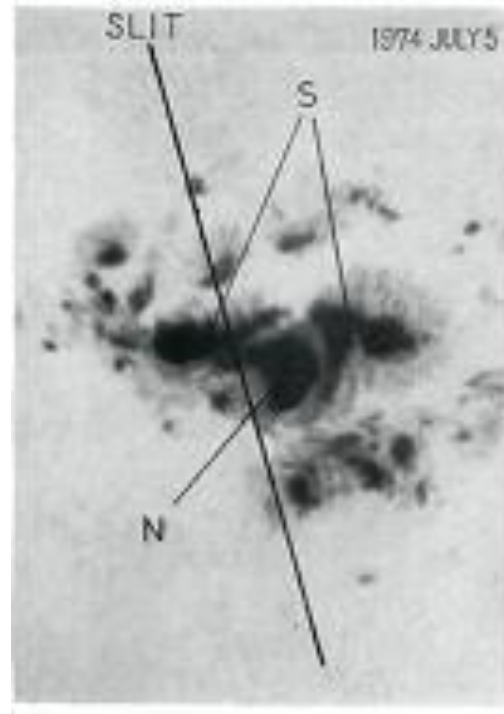


Ηλιακές κηλίδες

(φαινόμενο Zeeman για τη μελέτη του μαγνητικού πεδίου)

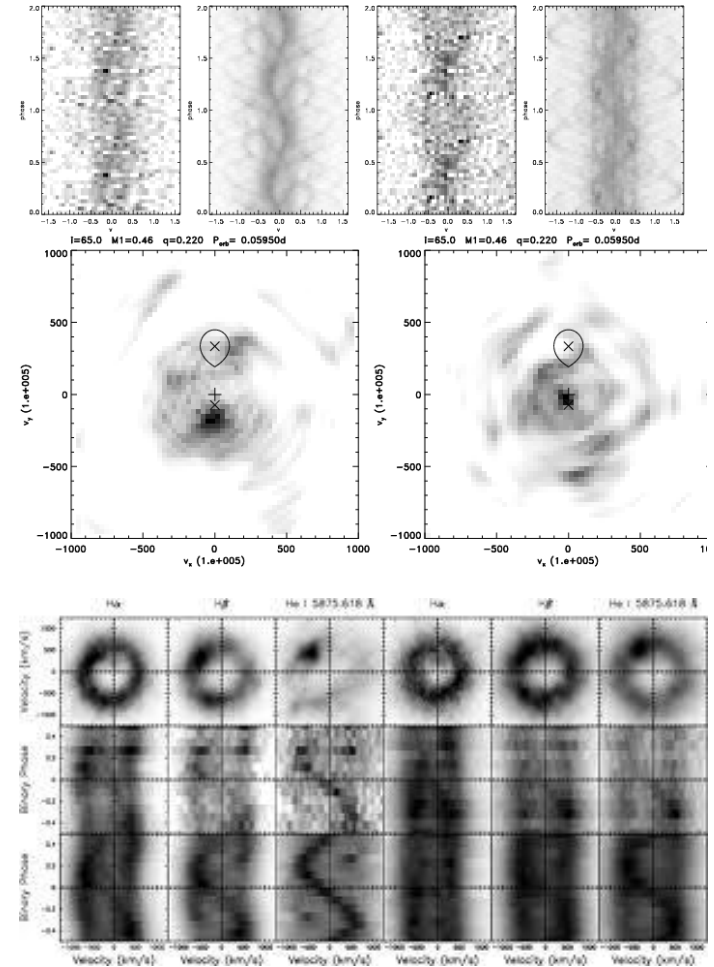
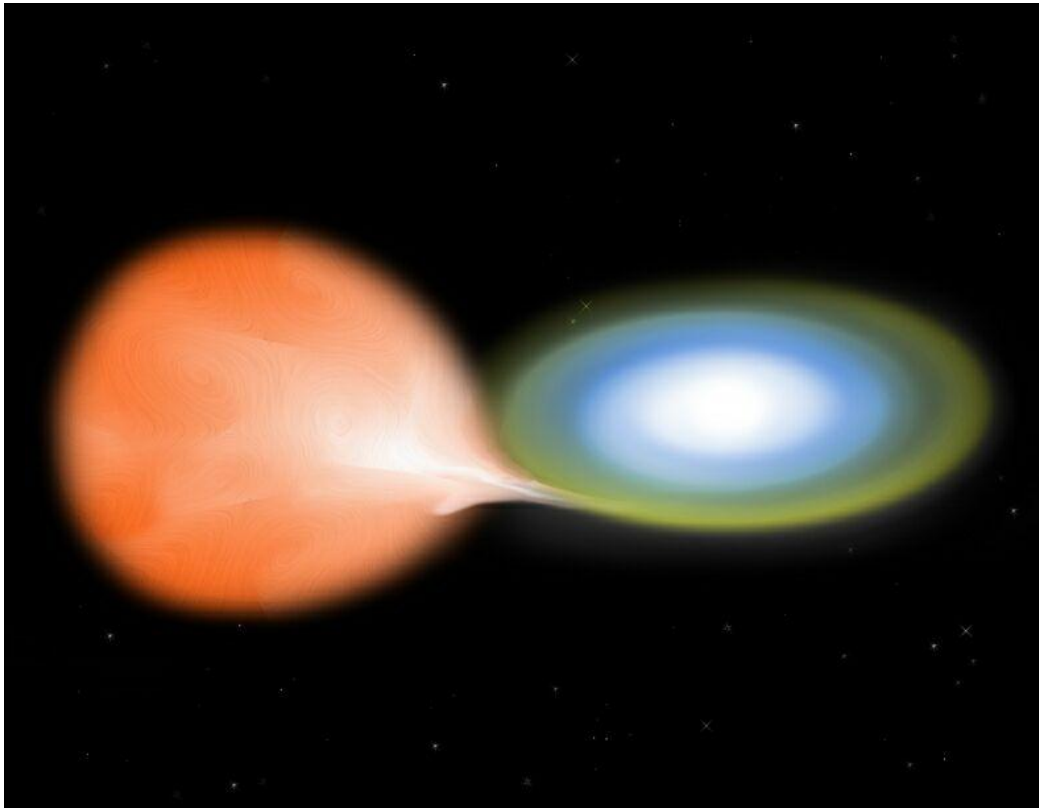


The Zeeman effect: a strong magnetic field splits the spectral lines into two or more components. The strength of the magnetic field can be measured from the amount of separation of the components. Sunspots are regions of strong magnetic fields.



Τομογραφία

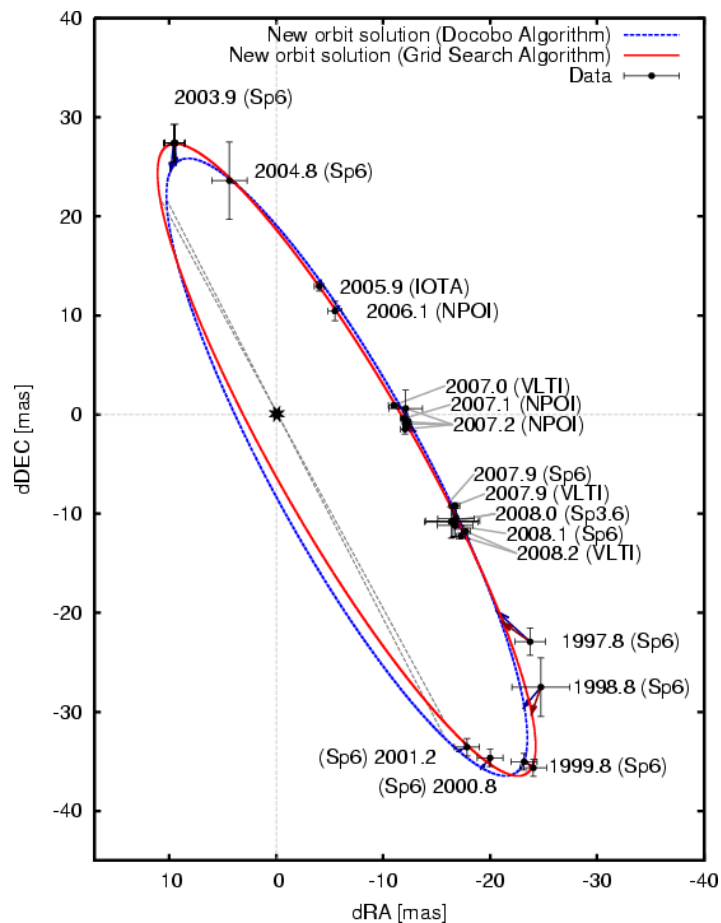
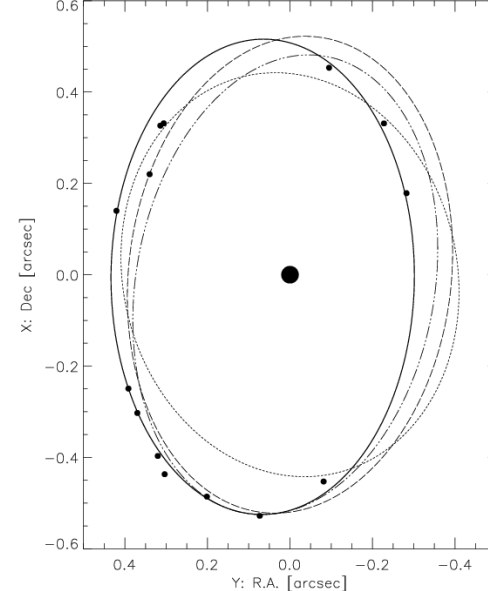
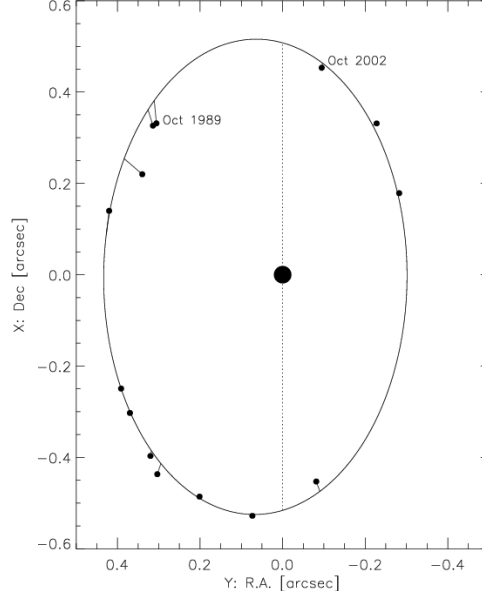
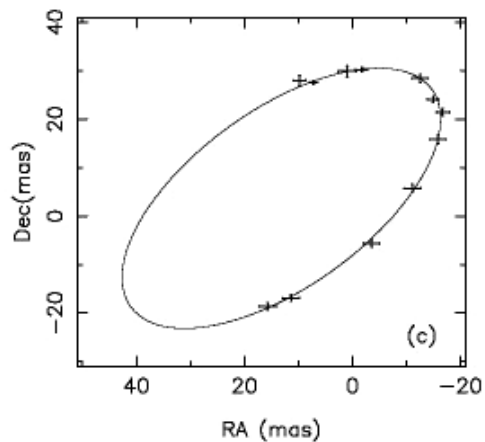
(απεικόνιση δίσκων προσάυξης και αστρικών επιφανειών)



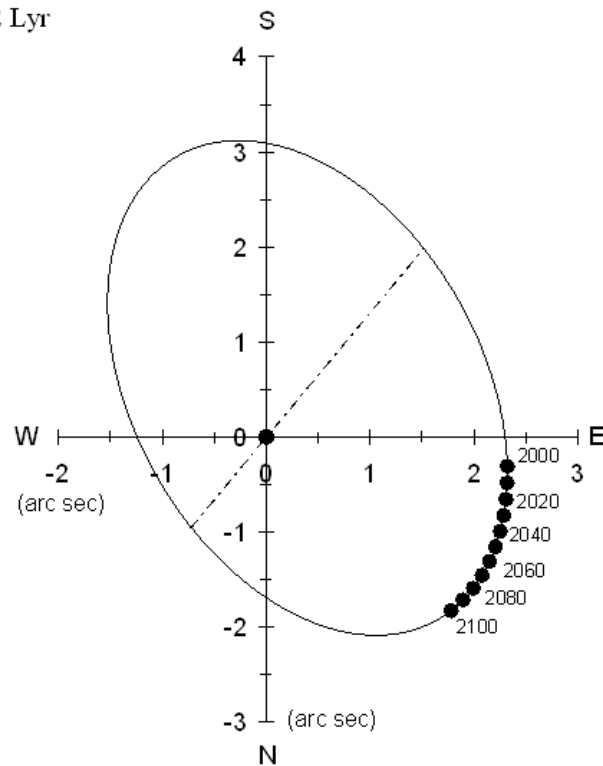
Αστρομετρία - Astrometry

Προσδιορισμός θέσης, κινήσεων και τροχιών





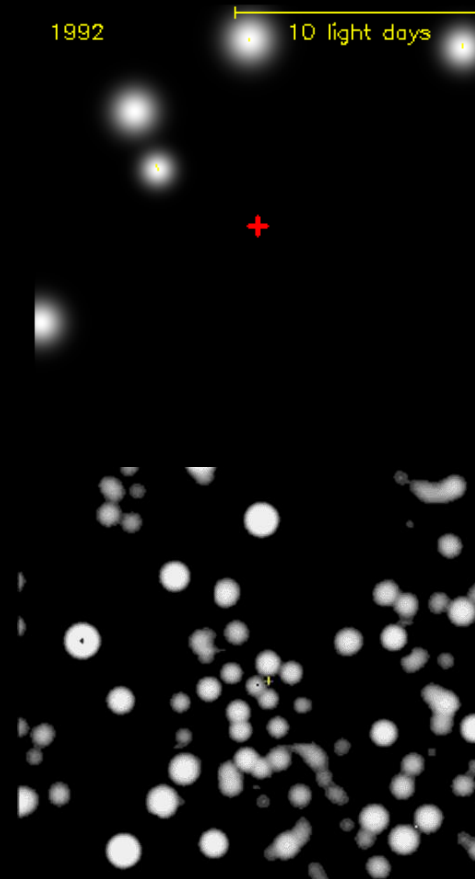
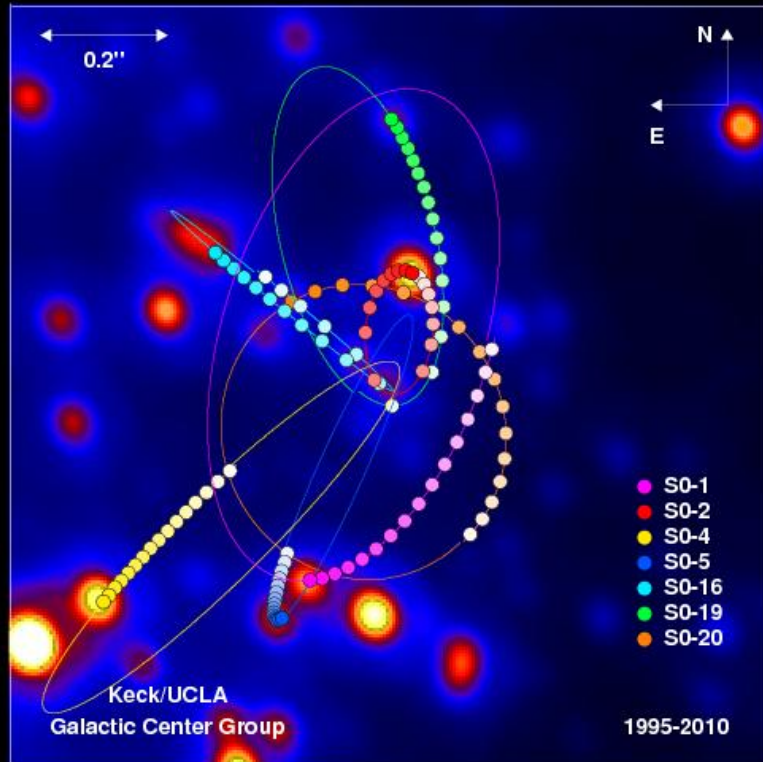
$\epsilon 2$ Lyr



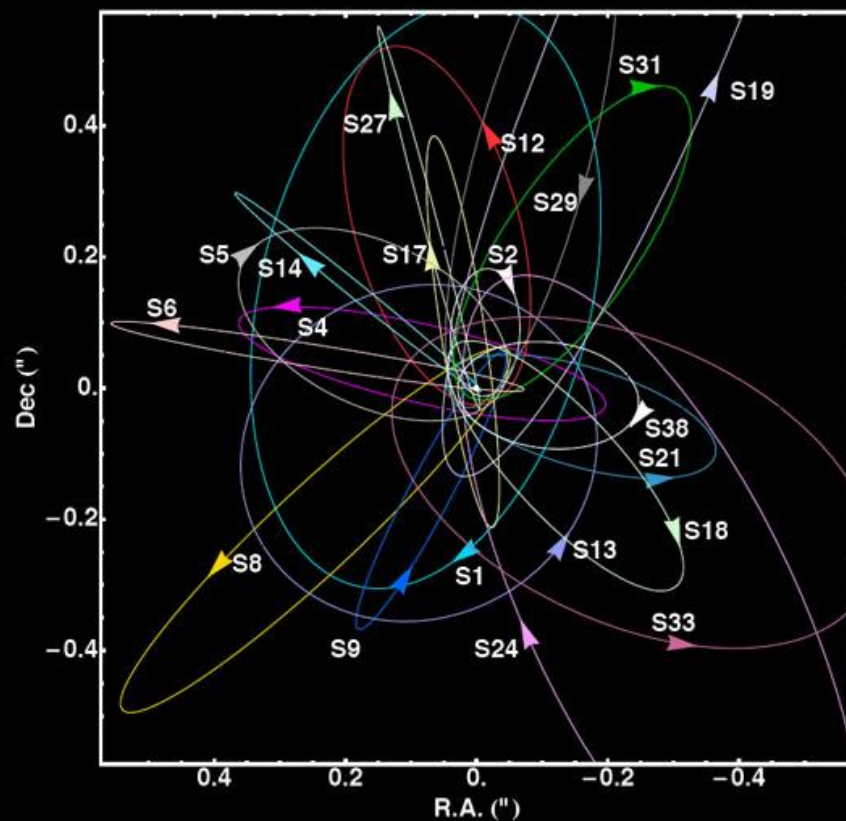
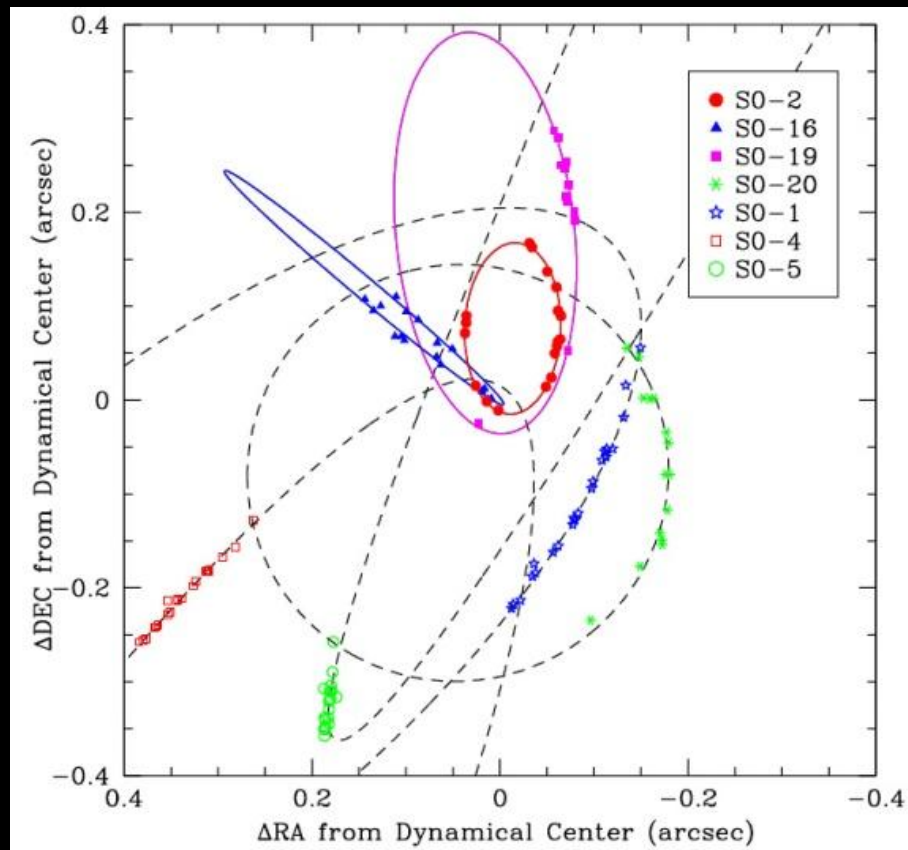
Name	Epsilon 2 Lyr
WD S	18443+3940
AD S	ADS 11635
Disco. Desig.	STF 2383C o-D
Position	RA 18h44.3m
	Decl. +39°40'
Period (year)	724.307
Peri. Pass. (year)	2223.934
Primary	Mag. 5.25
	Spectr.
Second.	Mag. 5.38
	Spectr.

Year	P.A. (deg)	Sep. (arc sec)
2000.0	82	2.34
2010.0	78	2.37
2020.0	74	2.40
2030.0	70	2.43
2040.0	66	2.46
2050.0	62	2.49
2060.0	59	2.52
2070.0	55	2.54
2080.0	51	2.55
2090.0	48	2.56
2100.0	44	2.55

Αstromετρία στο κέντρο του Γαλαξία

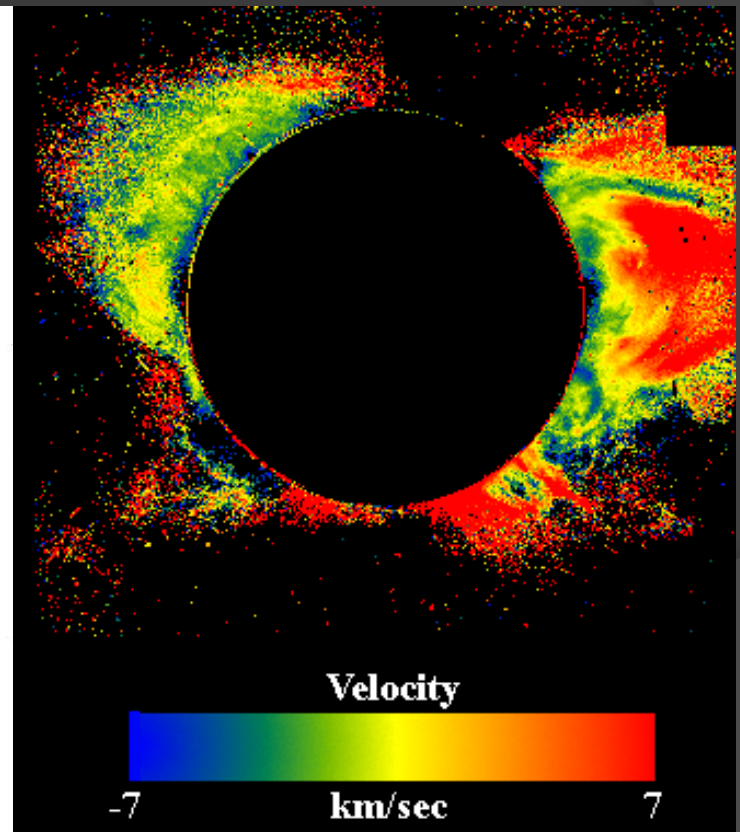
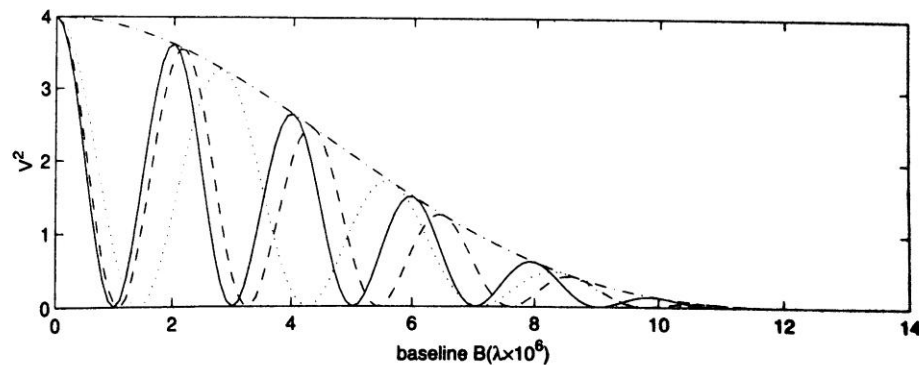
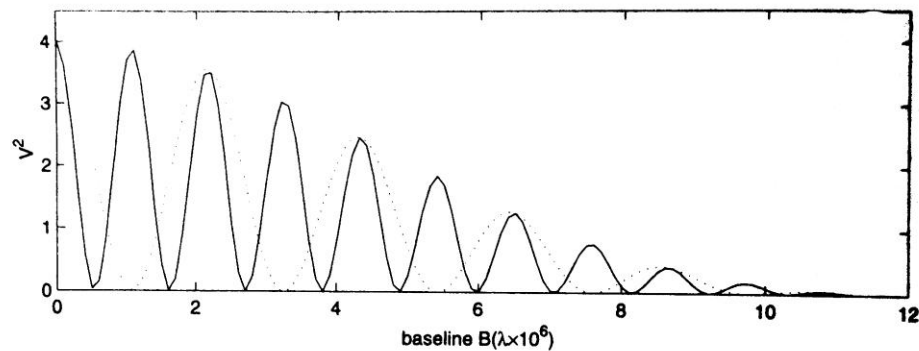


Αstrometρία στο κέντρο του Γαλαξία



Συμβολομετρία - Interferometry

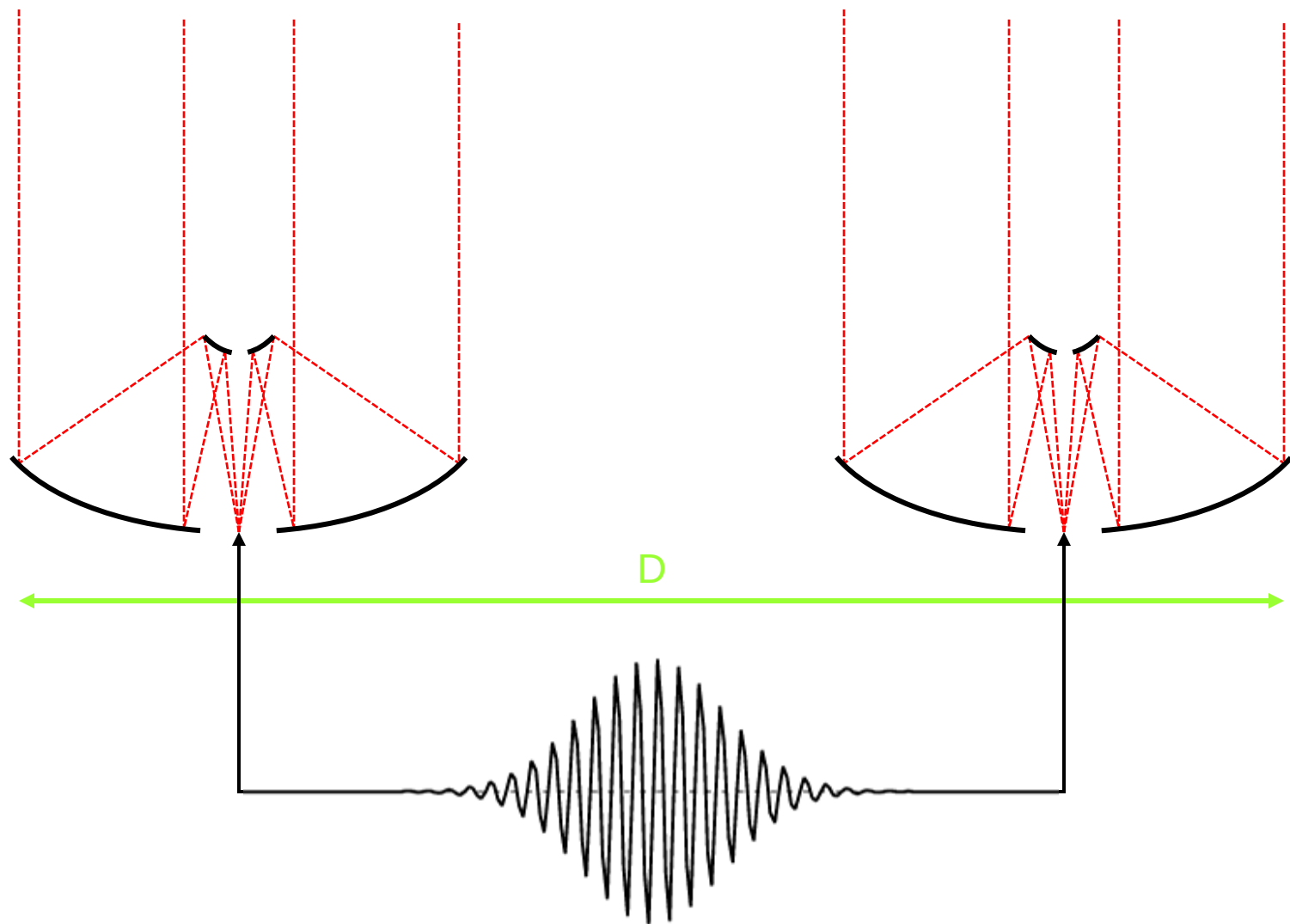
Συμβολομετρία → αύξηση διακριτικής ικανότητας



Ραδιοσυμβολομετρία

- Η τεχνική προτάθηκε, κατασκευάστηκε και τελειοποιήθηκε από τον Sir Martin Ryle (βραβείο Nobel Φυσικής 1974) στο Cambridge, UK.
- Σήμερα ραδιοτηλεσκόπια σε όλον τον κόσμο συνδυάζονται με την τεχνική της ραδιοσυμβολομετρίας, επιτυγχάνοντας εξαιρετικά μεγάλη διακριτική ικανότητα.







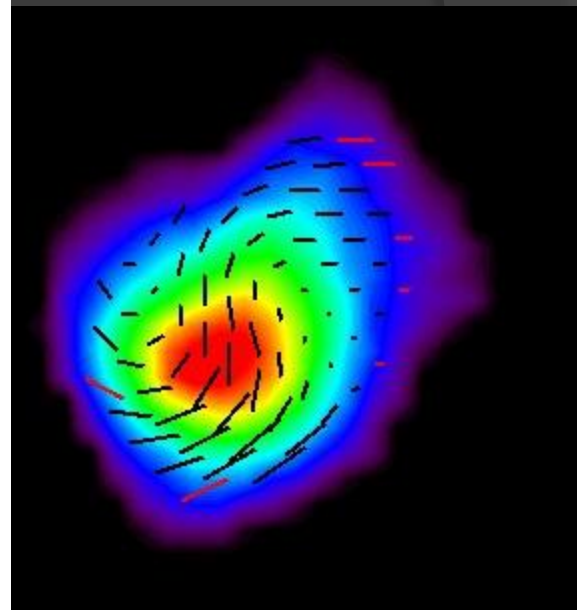
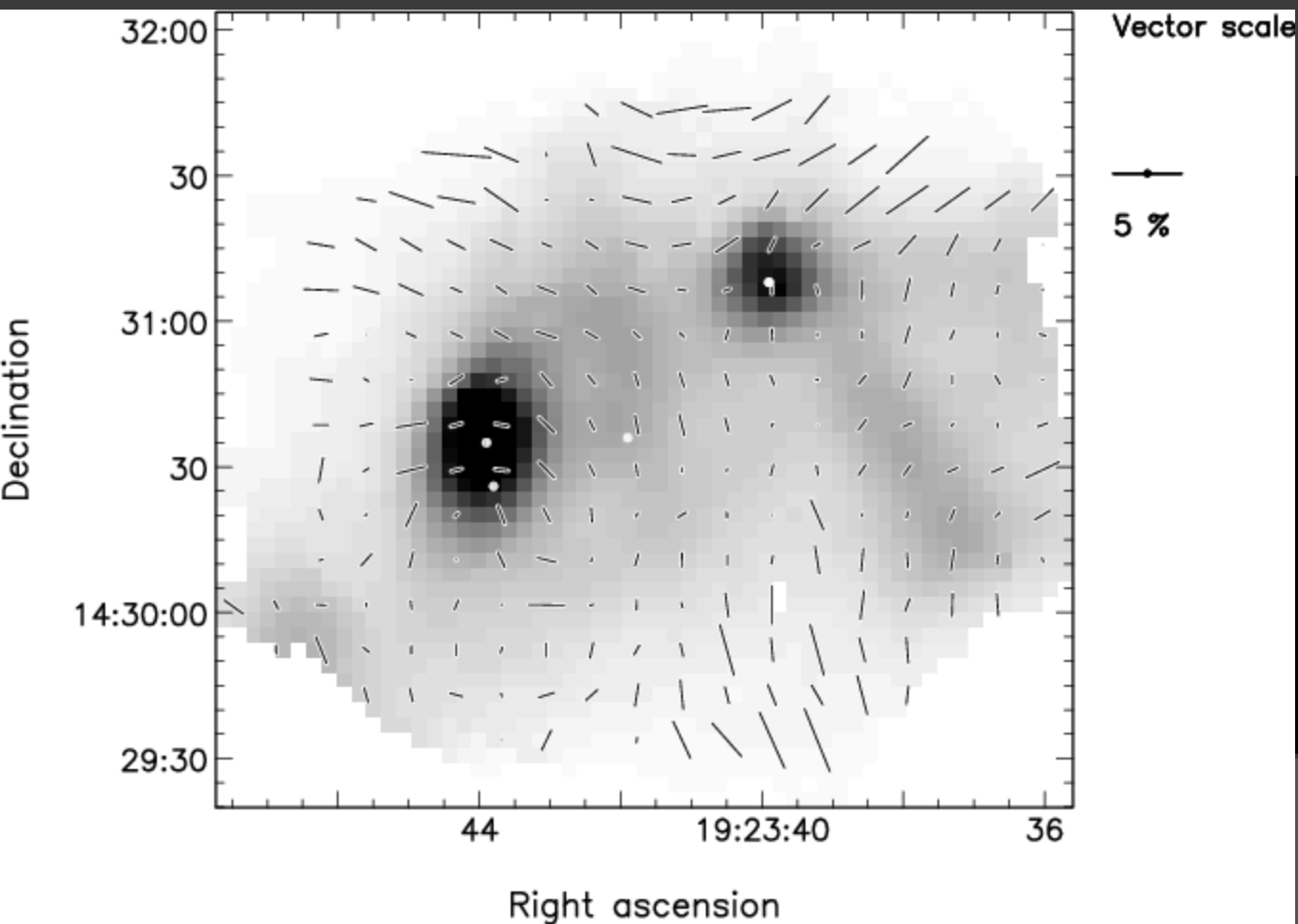
VLA (NM, USA) 27 ραδιοτηλεσκόπια διαμέτρου 25 m



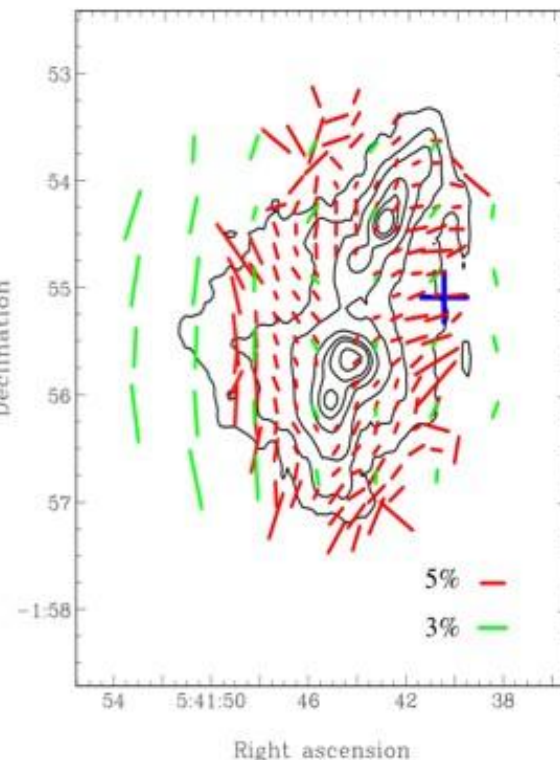
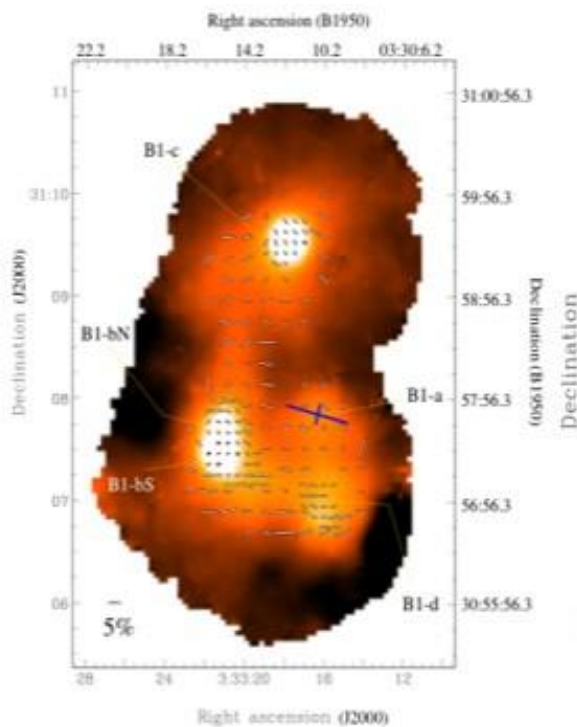
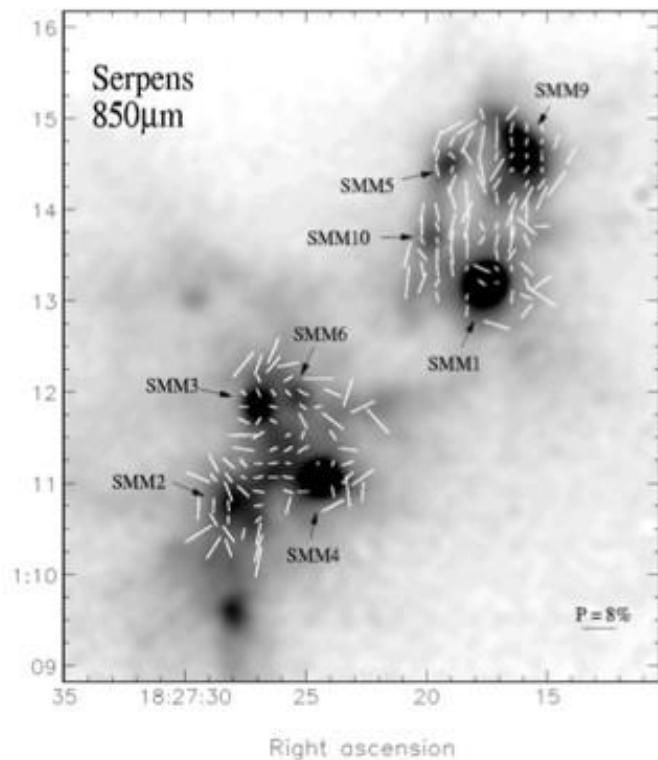
VLA (NM, USA) 27 ραδιοτηλεσκόπια διαμέτρου 25 m

Πολωσιμετρία - Polarimetry

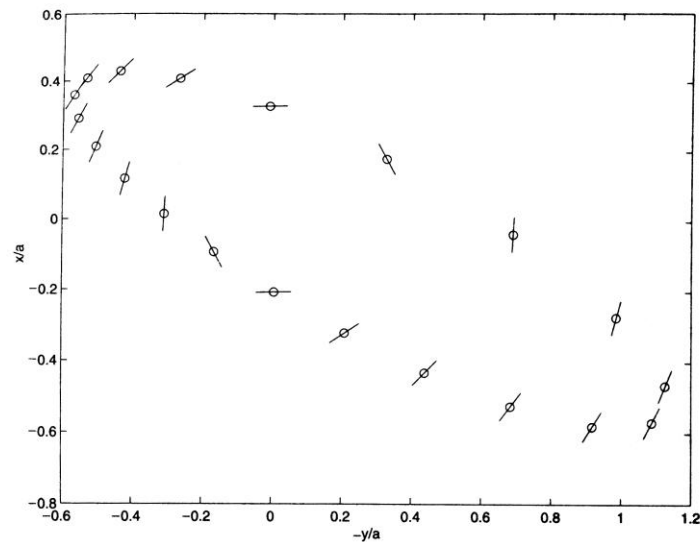
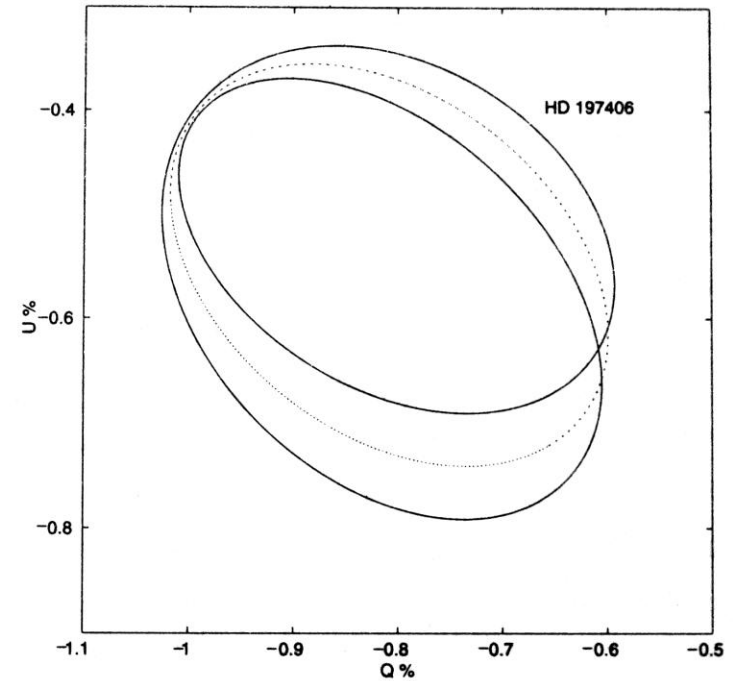
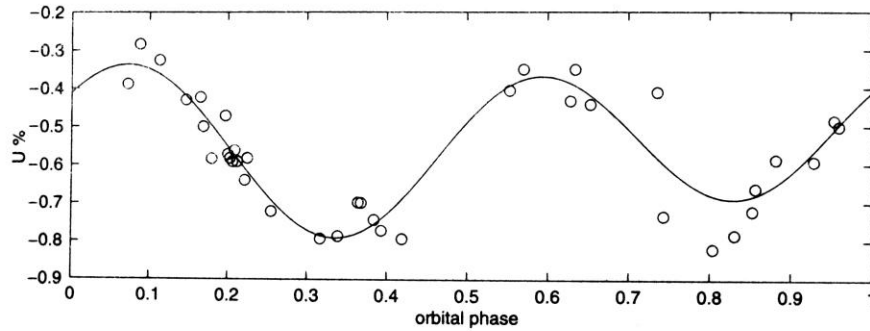
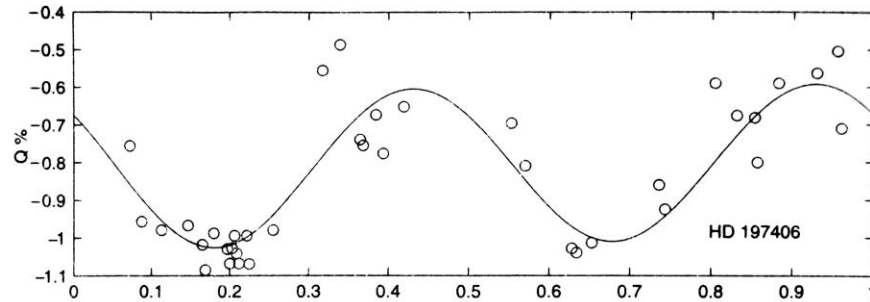
Μελέτη μεσοαστρικής ύλης μέσω των παραμέτρων Stokes



Πολωσιμετρικές παρατηρήσεις ενός νεφελώματος και η σύγκρισή του με άλλα μ.κ.



Πολωσιμετρικές παρατηρήσεις των παραμέτρων Stokes σε ένα διπλό αστρικό σύστημα



Stokes vector

The Stokes parameters can be arranged in a Stokes vector:

$$\begin{pmatrix} I \\ Q \\ U \\ V \end{pmatrix} = \begin{pmatrix} E_{0x}^2 + E_{0y}^2 \\ E_{0x}^2 - E_{0y}^2 \\ 2E_{0x}E_{0y}\cos \varepsilon \\ 2E_{0x}E_{0y}\sin \varepsilon \end{pmatrix} = \begin{pmatrix} \text{intensity} \\ I(0^\circ) - I(90^\circ) \\ I(45^\circ) - I(135^\circ) \\ I(\text{RCP}) - I(\text{LCP}) \end{pmatrix}$$

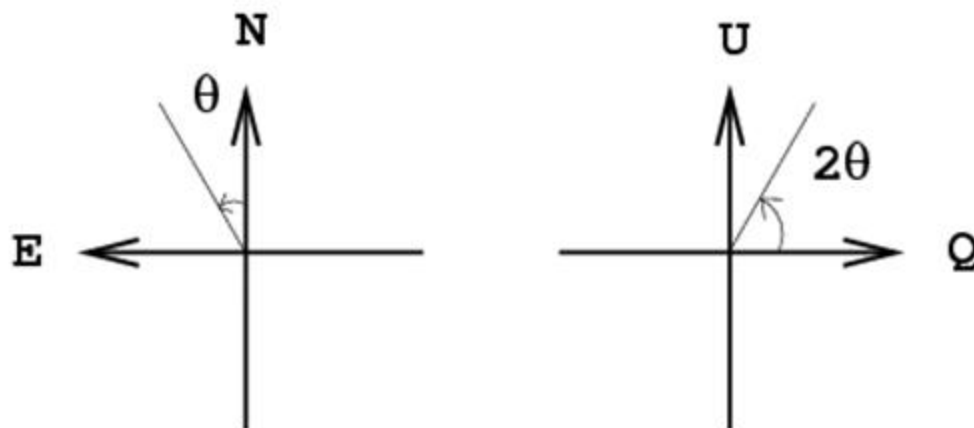
- Linear polarization $Q \neq 0, U \neq 0, V = 0$
- Circular polarization $Q = 0, U = 0, V \neq 0$
- Fully polarized light $I^2 = Q^2 + U^2 + V^2$
- Partially polarized light $I^2 > Q^2 + U^2 + V^2$
- Unpolarized light $Q = U = V = 0$

(Q, U) to (P, Θ)

In the case of linear polarization ($V=0$):

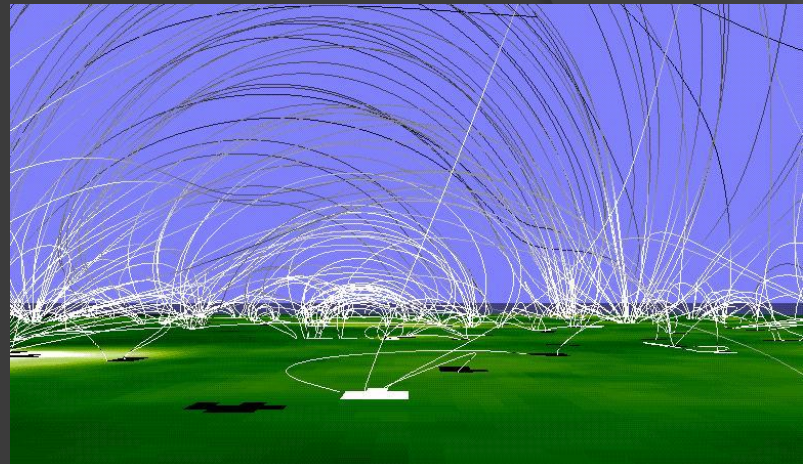
$$P = \frac{\sqrt{Q^2 + U^2}}{I} \quad \Theta = \frac{1}{2} \arctan\left(\frac{U}{Q}\right)$$

$$Q = P \cos 2\Theta \quad U = P \sin 2\Theta$$

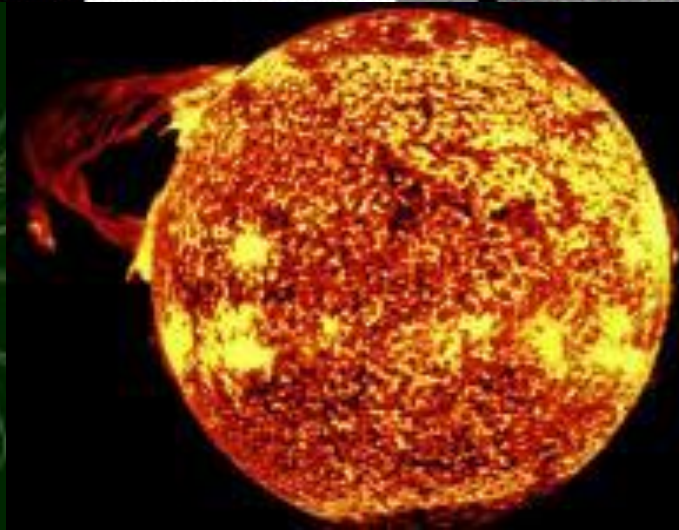
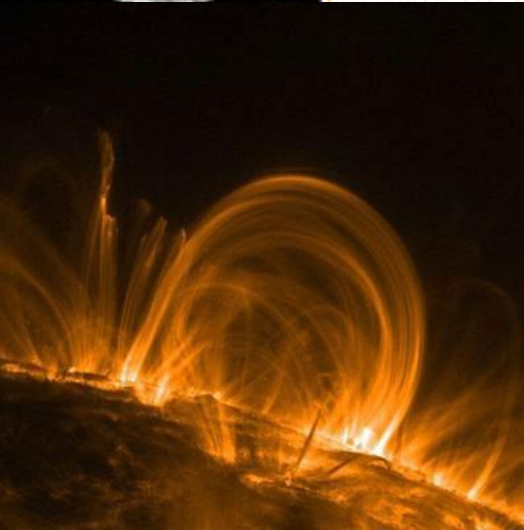
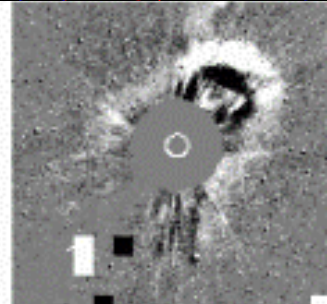
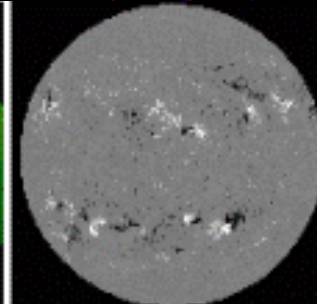
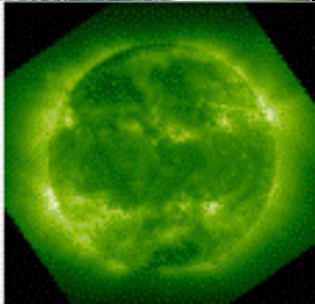
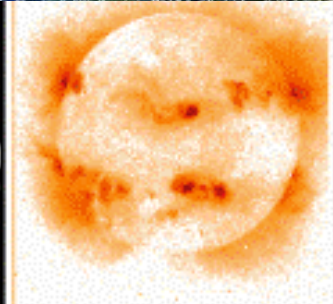
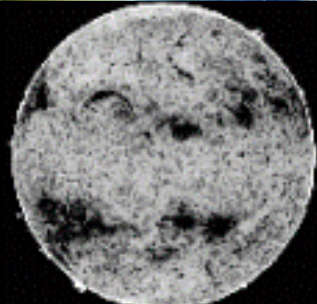
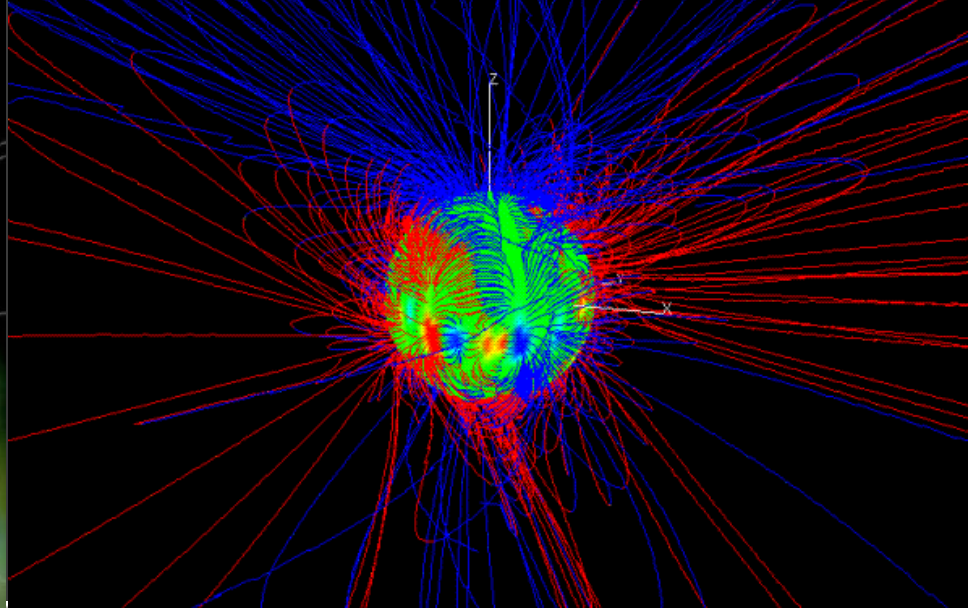
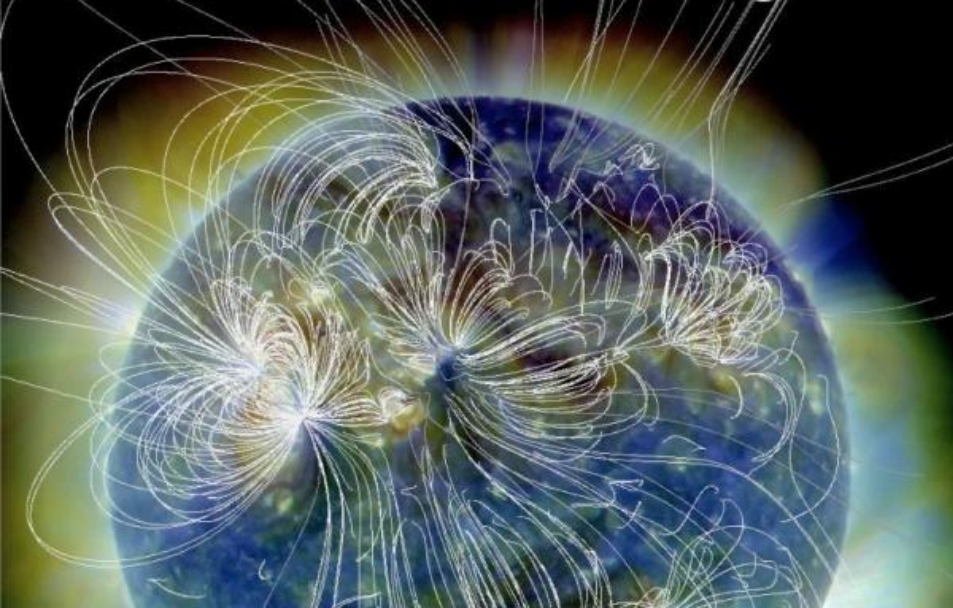


Μαγνητοτομετρία - Magnetometry

Μαγνητικό πεδίο στο σύμπαν







Formation of extragalactic jets from a black hole accretion disk

