Australian Government
Geoscience Australia

Observations of radio stars with geodetic VLBI

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+ collaboration of the Asia-Oceania VLBI project (AOV)

+ Russian VLBI network “Kvazar” + HartRAO + Sejong

Radio stars

Cataclysmic binaries (Miller-Jones et al., Science, 2013, 340, 950)

Spectroscopic binaries (RS CVn) (Ratner et al., ApJSS, 2012, 201, 5)

Algol-type binaries

Flux 1-10 mJy, bursts up to 100 mJy
Total number ~100 objects

12 radio stars were observed in 90s by DSN radio telescopes (JPL) to link radio and optical reference frames (VLBI and Hipparcos)

Kovalevsky et al (1997) A&A 123, 620
Lestrade et al (1999) A&A 344, 1014

VLBI observations (3 sessions)

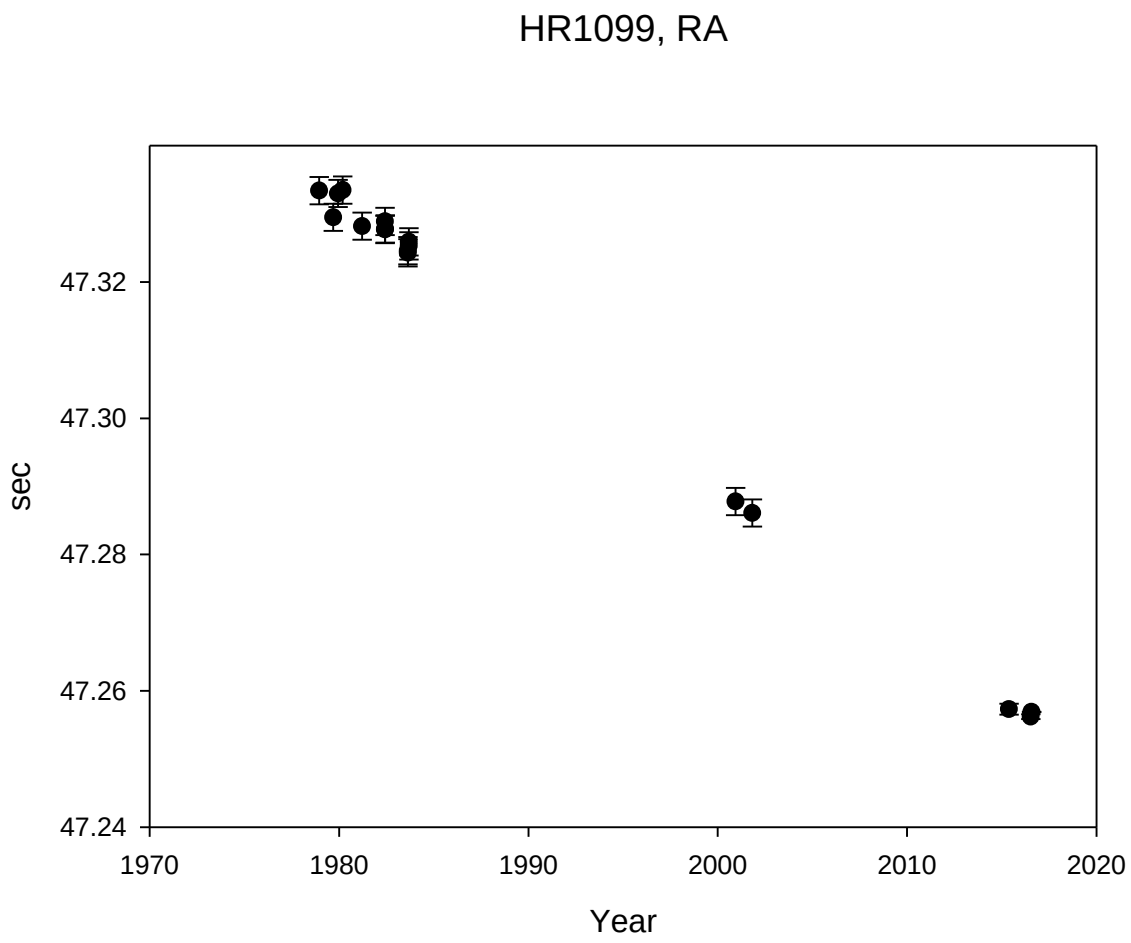
17 May 2015
(Kunming, Hobart26, Tianma65, Ishioka, Tsukuba + 12 meter dishes)

12 July 2016
(Parkes, Tianma65, Hobart 26, Kashima)

27 July 2016
(Kunming, Hobart26, Tianma65, Ishioka, Urumqi, Parkes, Seshan25 + 12 meter dishes)

HR1099 (V0711 Tau)
UX Ari
HD 132742

HR1099, RA



- Optical observations in 70-80s
- VLA observations in 90s

(Boboltz et al, AJ, 2003, 126 484)

- Three VLBI experiments in 2015-2016

Proper motion

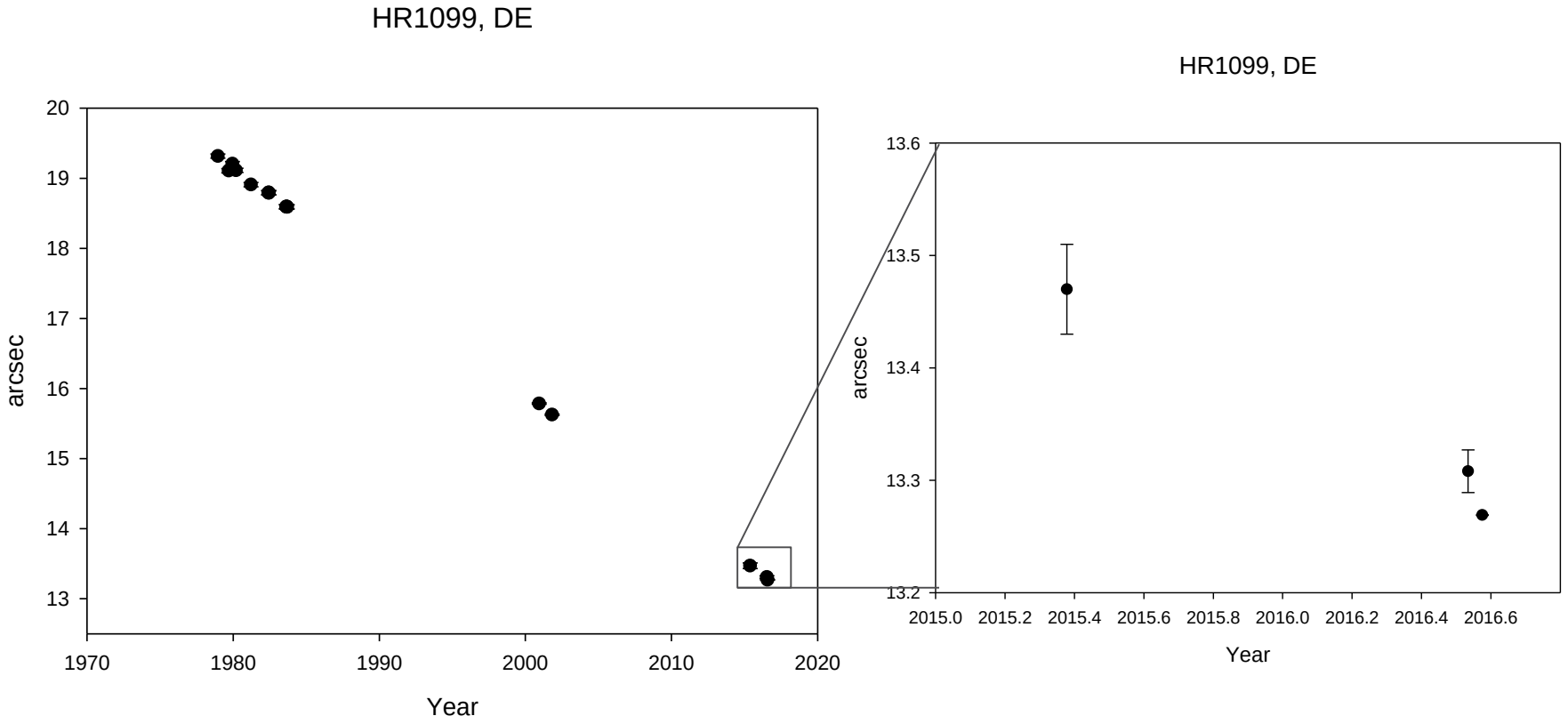
-2.120
+/- 0.020 msec/y

HR1099, DE

- Optical observations in 70-80s
- VLA observations in 90s *(Boboltz et al, AJ, 2003, 126 484)*

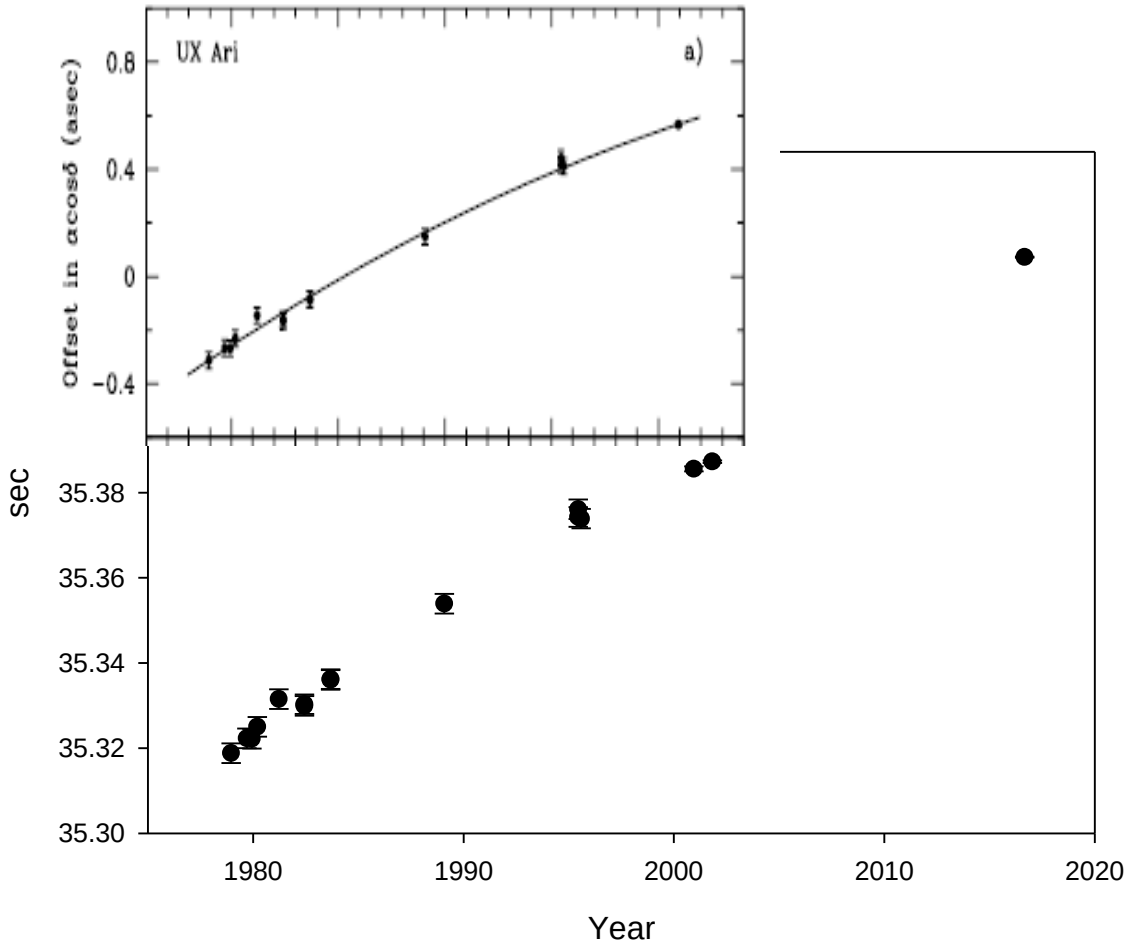
Proper motion

-161.44
+/- 0.73 mas/y



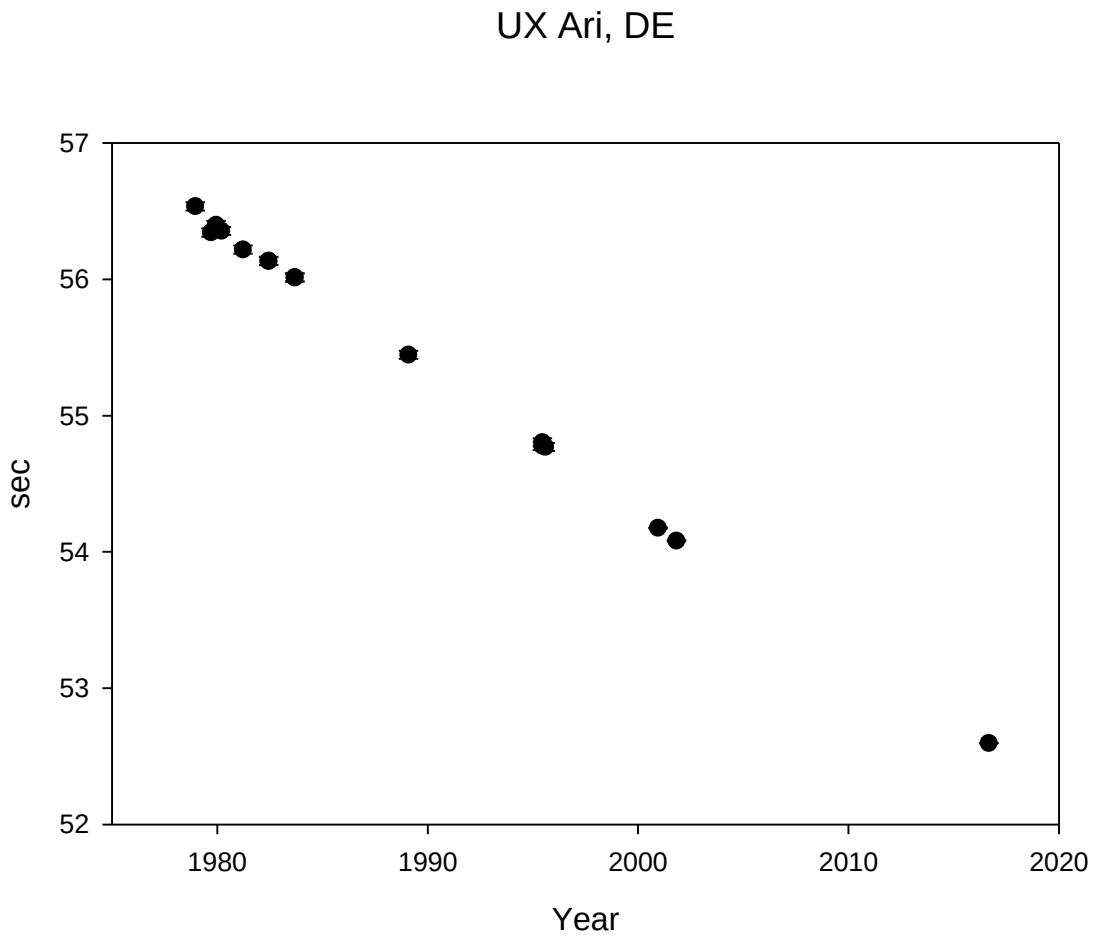
Formal error for the last session ~0.1 mas

UX Ari, RA



Boboltz et al (2003) AJ, 126, 484 (period 51.1 +/- 24.4 year)

UX Ari, DE



UX Ari, RA

For P = 50 years a = 0”.098 +/- 0”.035

LSI+61 303 (V0615 Cas)

RA = 02 40 31.6641883136
DE = +61 13 45.591138110
R = 10.3
High-mass X-ray binary, Gamma-source

Optical observations Gaia DR2
Parallax 0.380 +/- 0.038 mas
Proper motion

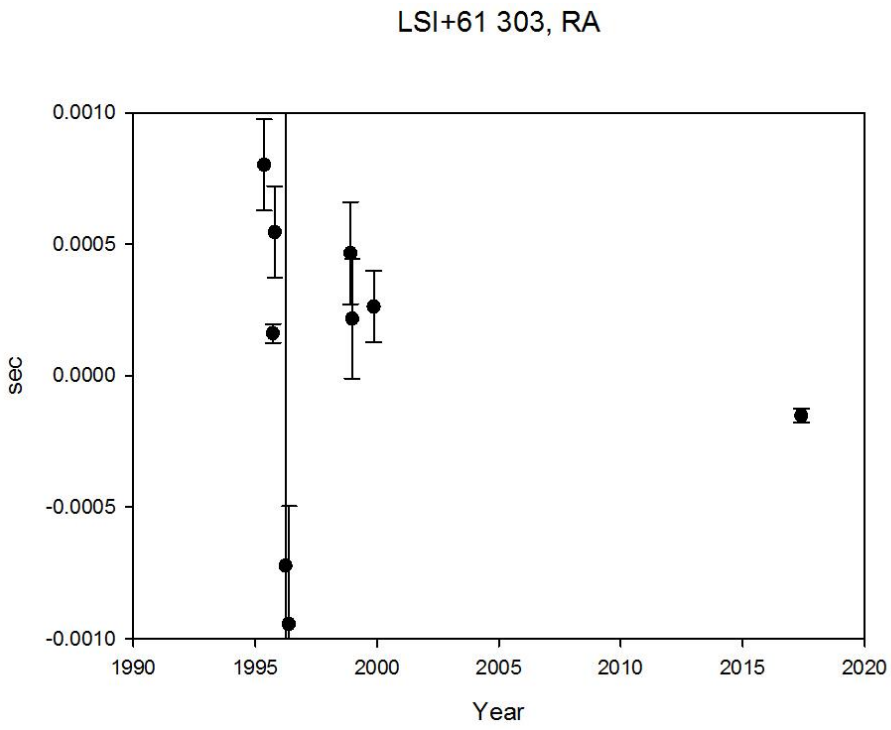
$$\mu_\alpha = -0.296 \pm 0.041\ mas/y$$
$$\mu_\delta = -0.079 \pm 0.067\ mas/y$$

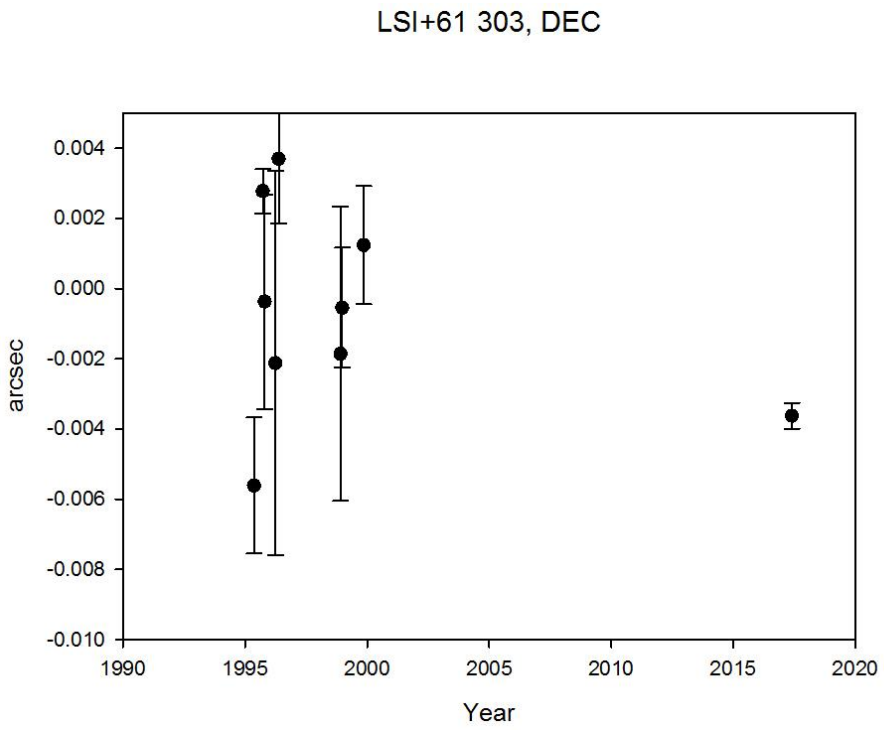
10-May-1995
19-Sep-1995
17-Oct-1995
25-Mar-1996
14-May-1996
24-Nov-1998
22-Dec-1998
09-Nov-1999

17-May-2017 (VLBA+)

less than 10 delays per session!

LSI+61 303 (V0615 Cas)





Optical observations Gaia DR2

Proper motion

$$\mu_\alpha = -0.296 \pm 0.041\ mas/y$$

$$\mu_\delta = -0.079 \pm 0.067\ mas/y$$

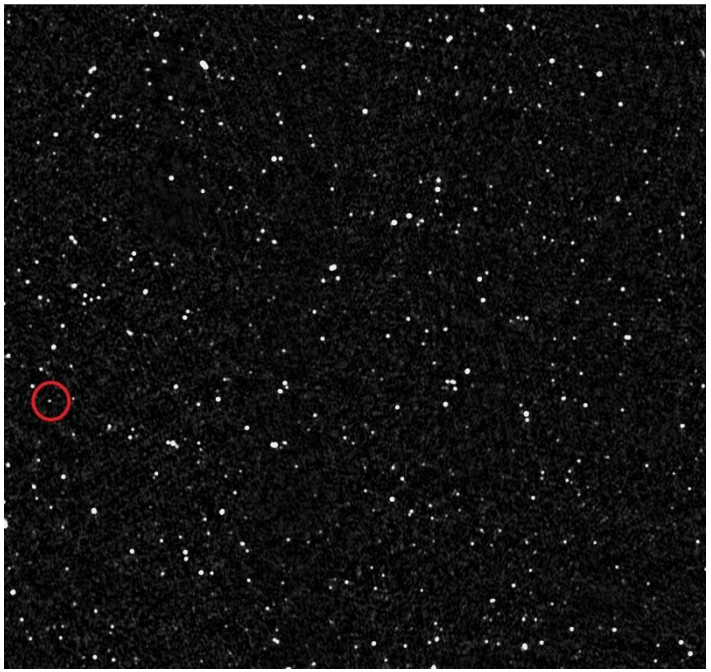
Potential observations

Networks:
VLBA, EVN, LBA, EAVN, IVS, etc

Phase reference astrometry in a single band
Or
Absolute astrometry in S/X

Typically, six experiments are required (3 years, every 6 months) to separate parallax and proper motion

V1054 Oph, Wolf 630, HD152751 (NVSS, SDSS DR14, DSS2, Hipparcos)

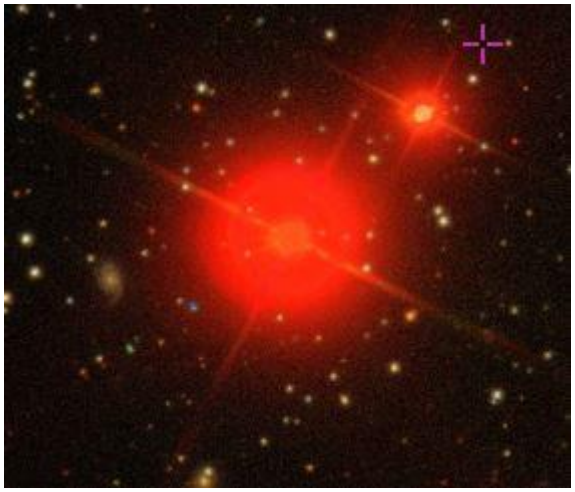


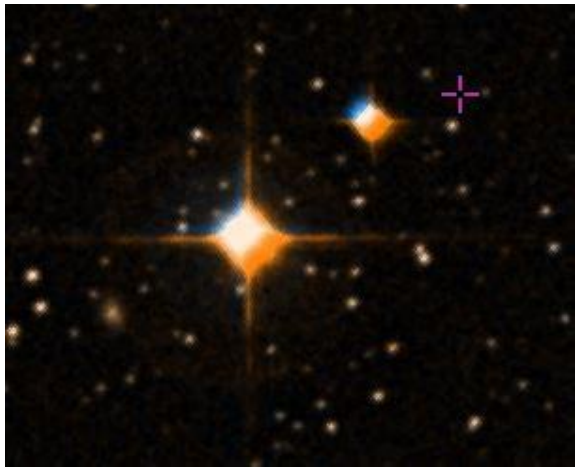
$\pi = 174.2 \pm 3.9$ mas

$\mu_\alpha = -0.829$ "/year

$\mu_\delta = -0.878$ "/year

NVSS flux ~ 11 mJy in 1.4 GHz



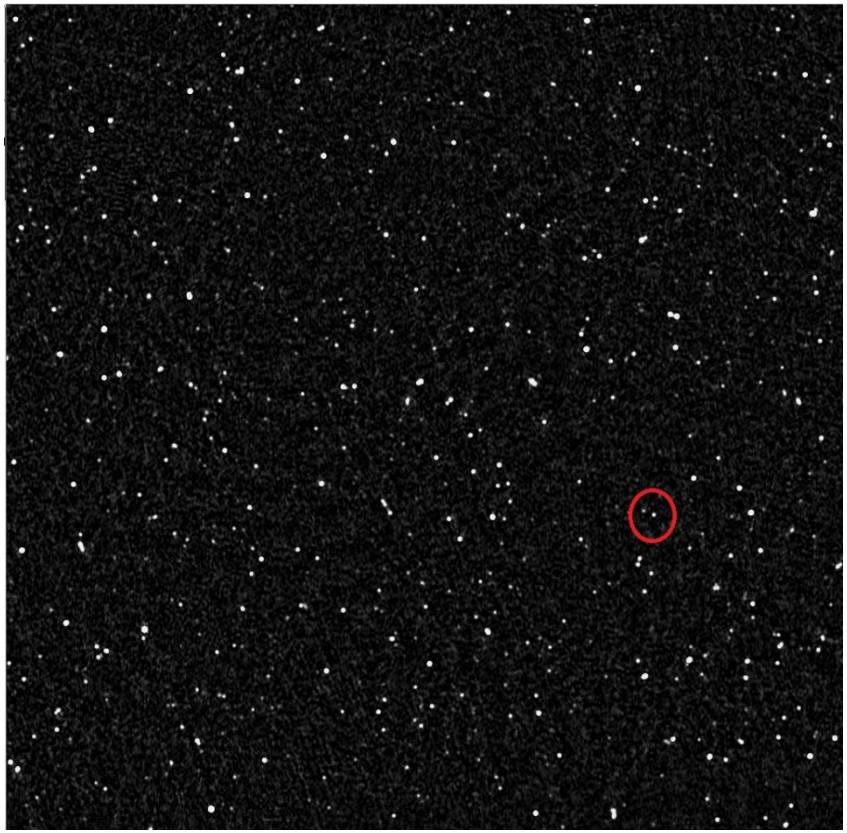


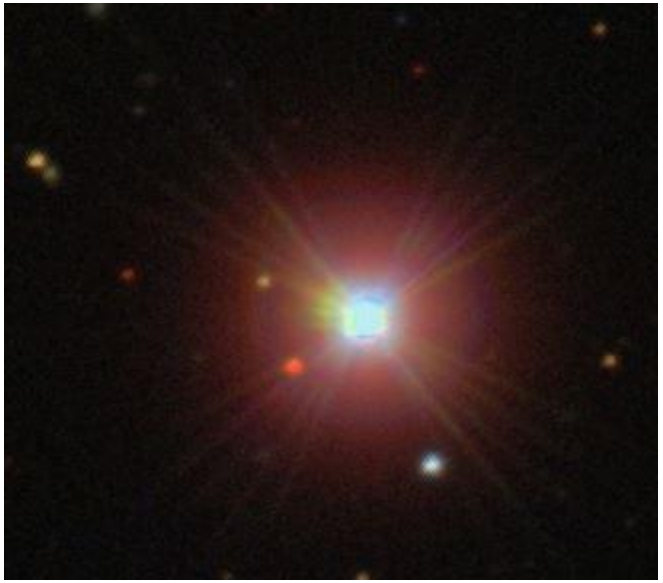
VLA
1.4 and 4.8 GHz

Jackson et al
A&A (1989)
210, 284

Flux
~1 mJy 1.4 GHz
~3 mJy 4.8 GHz

HD220374 – (new?) radio star (NVSS, SDSS DR14, Gaia DR2)





$\pi = 4.4 \pm 0.2$ mas

$\mu_\alpha = -10.5 \pm 0.3$ mas/year

$\mu_\delta = -14.8 \pm 0.3$ mas/year

Conclusion

1. Geodetic VLBI observations have a capacity to observe weak galactic radio stars
2. Large radio telescopes and modern technology are required
3. Daily positions of a radio star could be measured with precision of 0.1 mas or better (subject of flux, etc).
4. Scientific goals: linear or non-linear proper motion, invisible companion, parallax, etc.
5. Verification of the Gaia mission results
6. Link between optical and radio reference frames

Any Questions?

Thank you for your attention

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