Distances based on Mira variables.

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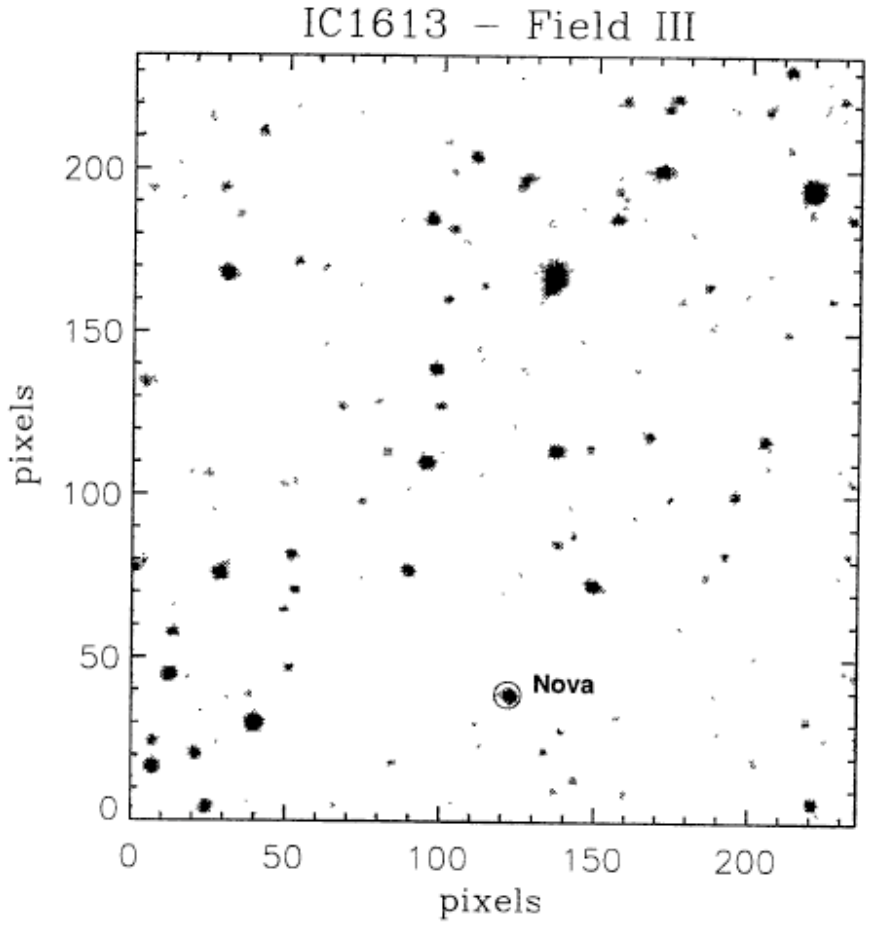
A short story

- 1999 King et al reported a nova in the galaxy IC 1613. (King et al. 1999, IAUC, 7287)

A short story

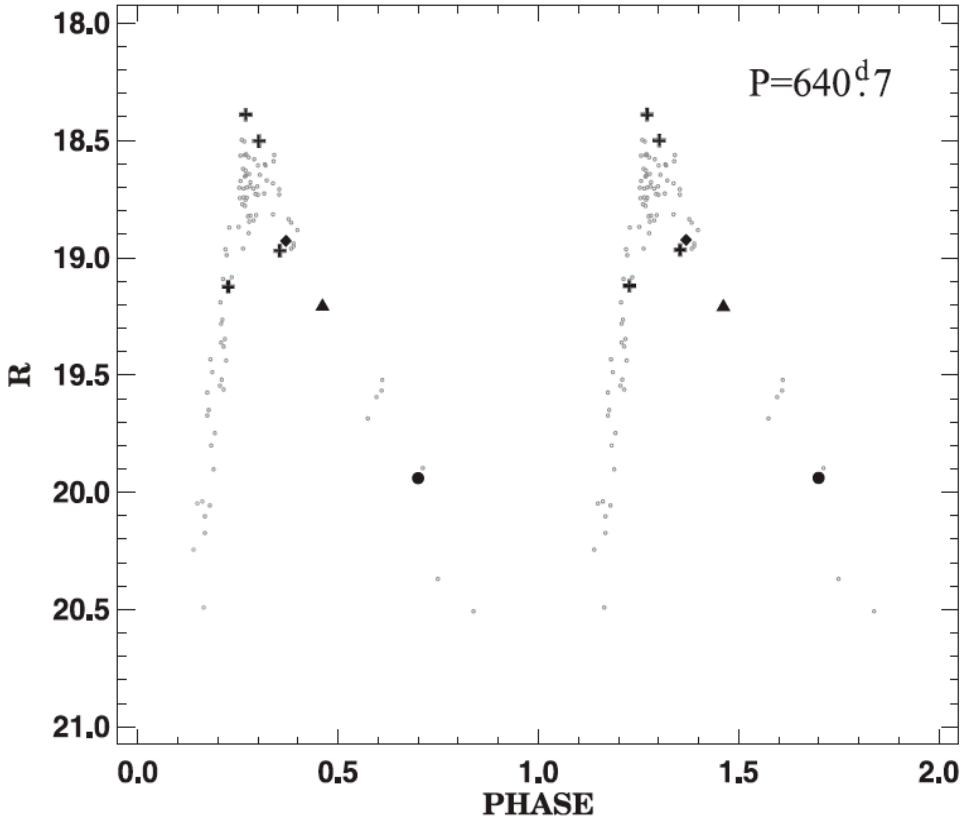
- The star were detected on our images taken on October 15, 1998 at SPM. Based on its IR colors, we suggested that the star is a Mira.

(Borissova, J. Georgiev, L. Kurtev, R., et al. 2001, RMA&A, 36, 151).

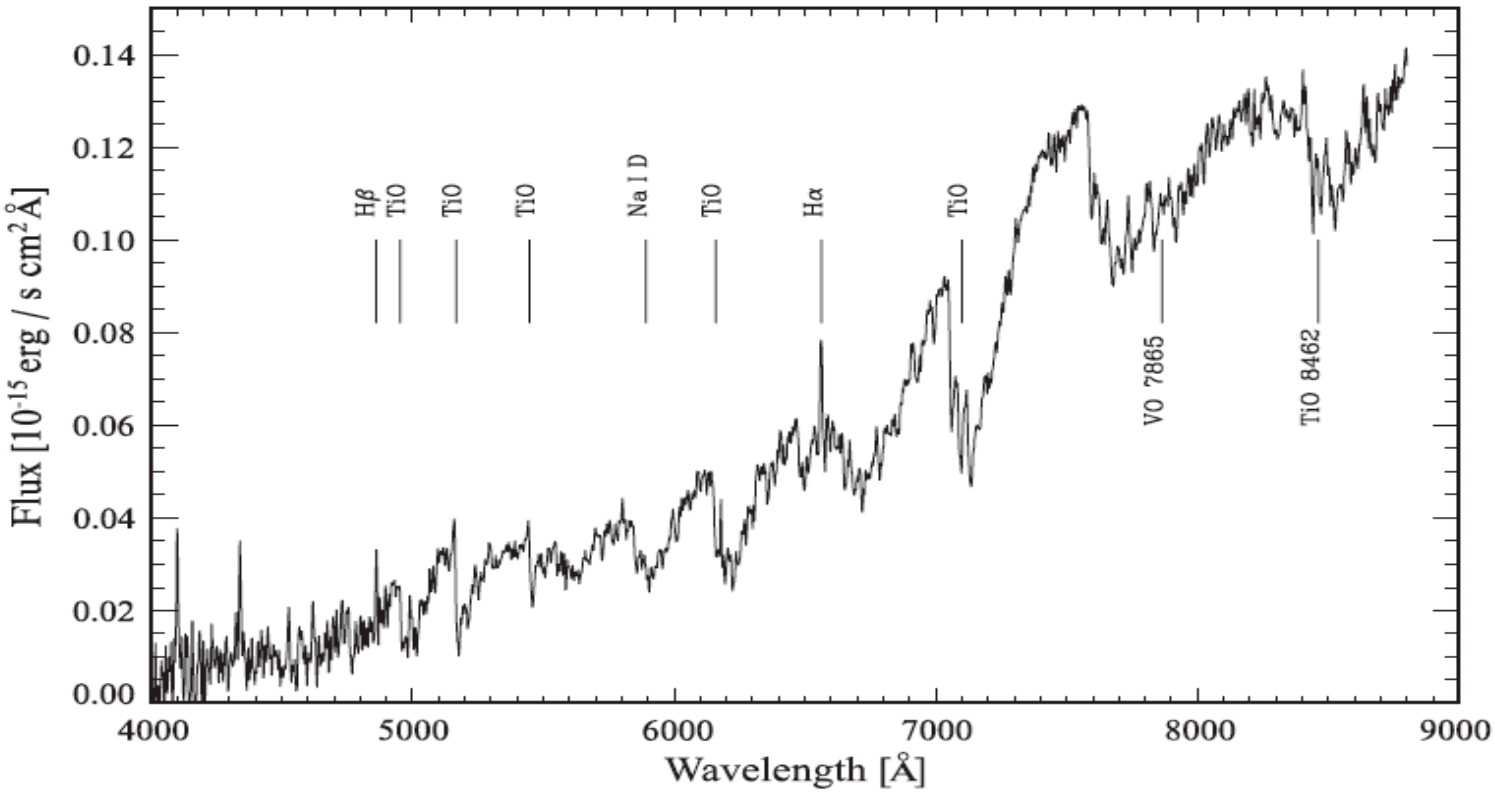


A short story

- Photometry of archival images confirms a variable with period of 641 days.



A short story



Kurtev, R. Georgiev, L. et al. 2002, A&A, 387, 449.

Mira variables

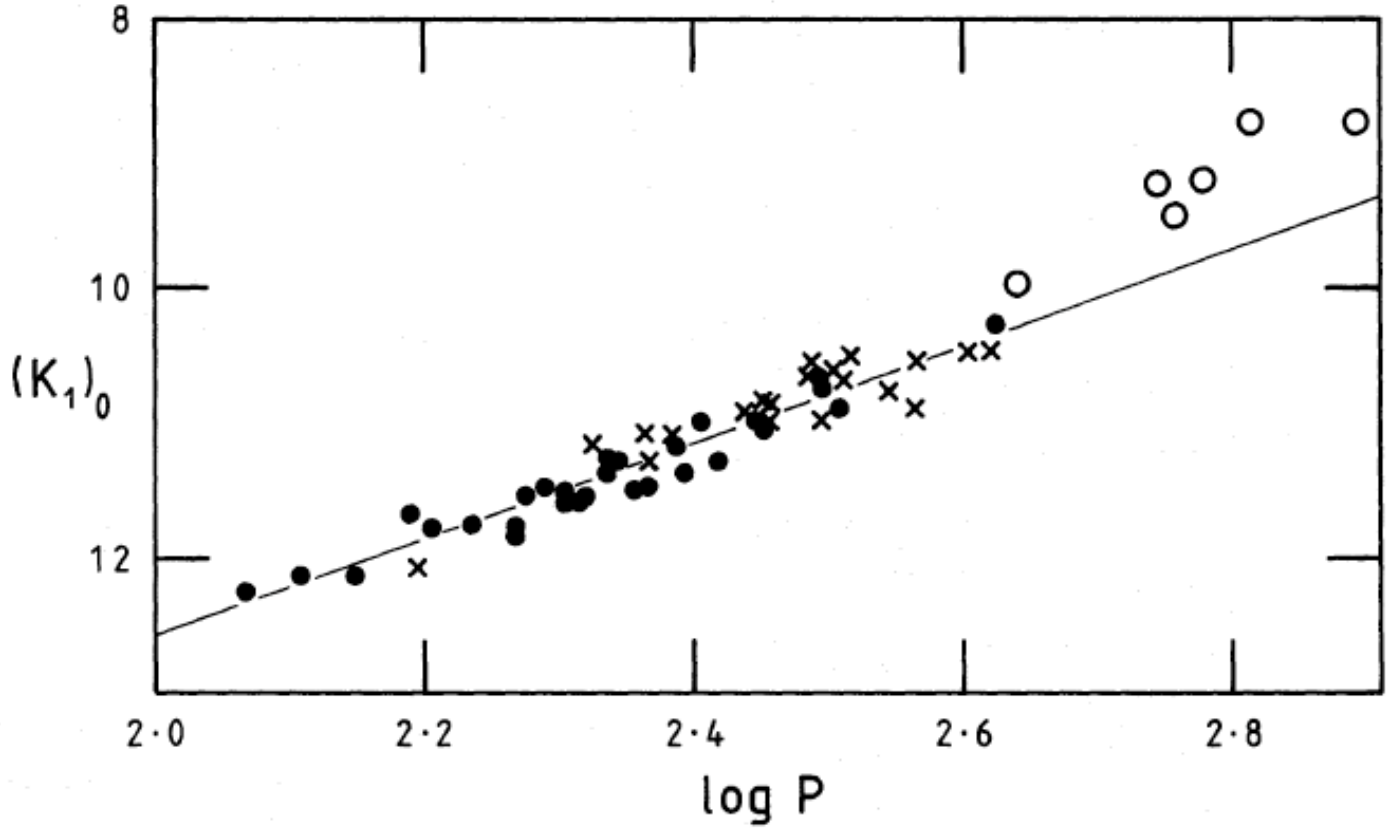
- AGB stars undergoing thermal pulses. The variability is caused by hydrodinamical instability. The pulsations stops in the minimum of the thermal pulse.
- Amplitude of variability is greater than 0.4 mag in K
- The amplitude increase toward the blue wavelengths.
- Periods between 100 and 1000 days.
- Masses ~ 1.8Msun, age ~ 1.8Gyr.

Why Miras

- They have a good Period-Luminosity relation which seems independent of the metalicity (Feast, 2008, astro-ph, 0806-3019).

$$Mk = -3.56 * \log P + 1.14$$

Why Miras



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  $Mk = -3.56 * \log P + 1.14$

- The stars are bight and can be easylly detected at large distances.
- A star with period of ~400 days has Mk = -8.0.
  Assuming a detection limit of K=22 mag, the star can be detected at 4 Mpc allowing 2 mag for amplitude.

Why Miras

- Sampling rate.
  - Shorter period which can be extracted from the data is determined by the Nyquist frequency (minimum two sampling points per period). Periods of >100 days needs one sampling every ~50 days => roughly 30 measurements.
  - Issues with the precision of the periods.
- Other variable stars will need much denser sampling
  - RR Lyr have periods ~ 1 day => needs two observations per night
  - Cepheids with P ~ 20 days needs sampling every few days.

Can it be done?

Rejkuba, 2004, A&A, 413,903, “The distance to the giant elliptical galaxy NGC 5128”

- Giant eliptical galaxy at distance 28 mag.
- Data obtained with ISAAC camera on UT1 in 24 epoch covering about 1000 days.
- Measured stars with K < 22.5 in two 2.5 X 2.5 arcmin fields with ~0.15 arcsec/px at seeing 0.5 arcsec
- Detected about 50 long period variables
- The Miras in NGC5128 follow the same PL relation as those in LMC.
- Derived distance 27.98 ± 0.11 mag. = 4 ± 0.2 Mpc

Can it be done?

- Three Mira variables are detected in Phoenix galaxy
- At least 1 Mira in Leo I dwarf spheroidal galaxy.
- Observations with Japanese-South African 1.4m Infrared Facility (IRSF)

About IRSF (from their home page)

- We made and constructed the telescope at Sutherland, SAAO(South Africa Astronomical Observatory). We, mainly Z-Lab, planned a near-infrared survey observation in Southern hemisphere region. So we developed SIRIUS(Simultaneous-3color InfraRed Imager for Unbiased Survey) and the telescope for the survey. We made the telescope collaboration with Nisimura telescope company. We started the construction **on November in 1999**, and got the firstlight at Sutherland **on Sep 27, 2000**. And we got the firstlight with using the telescope and SIRIUS on **Nov 27, 2000**.

Possible observational strategy

- The K band is necessary
  - It is nice (Cruz-González, I, 2008, this workshop)
  - The Period-Luminosity relation is defined in this band. The PL in other bands is noisier
  - The K-band Cepheid PL is less sensitive to the metalicity.
- After the first scan of the sky, all resolved galaxies are selected and visited again every 20-40 days.
- All variable stars with amplitude bigger than 0.4 mag in K and with J-H, H-K colors corresponding to Miras are selected
- The stars with good periods and light curves close to sinosoidal are used as distance indicators.

Expected results

- A 3D map of the local universe (with in 4 Mpc) made with the same yard stick.
- Check of the PL relation at different environments.
- Check of the maximal period of the Long Period Variables (LPV) => consequences for the evolutionary theories of AGB.
- Deep photometry of the host galaxy and the surrounding field. The sum of the visits will give 3-5 times improvement of the S/N => discovery of faint quasars?