Speckle Imaging at the WIYN 3.5-m Telescope

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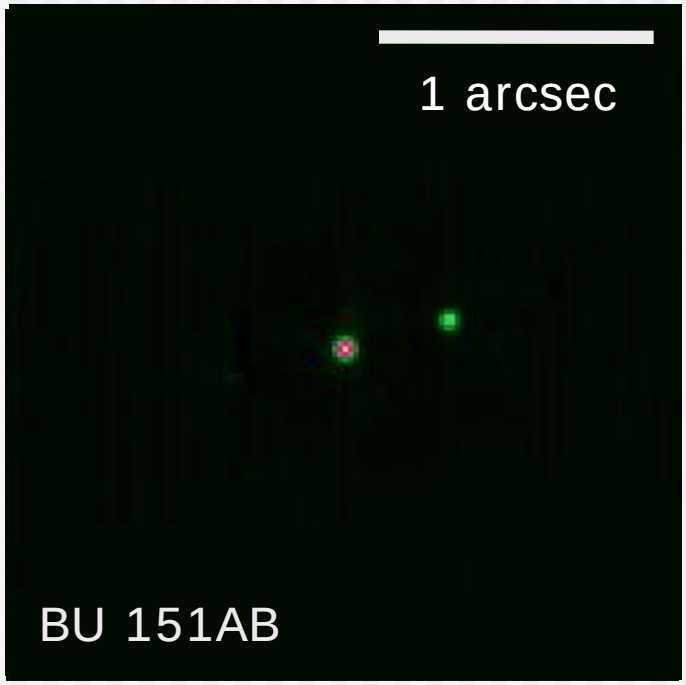
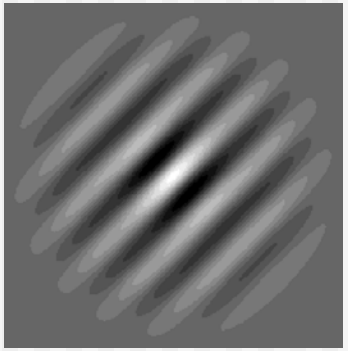
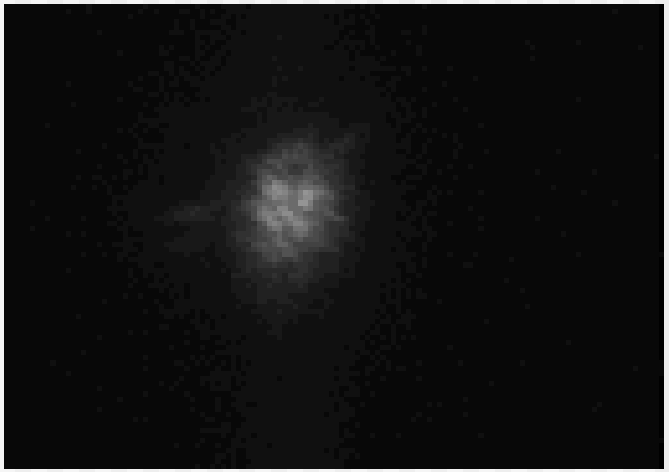


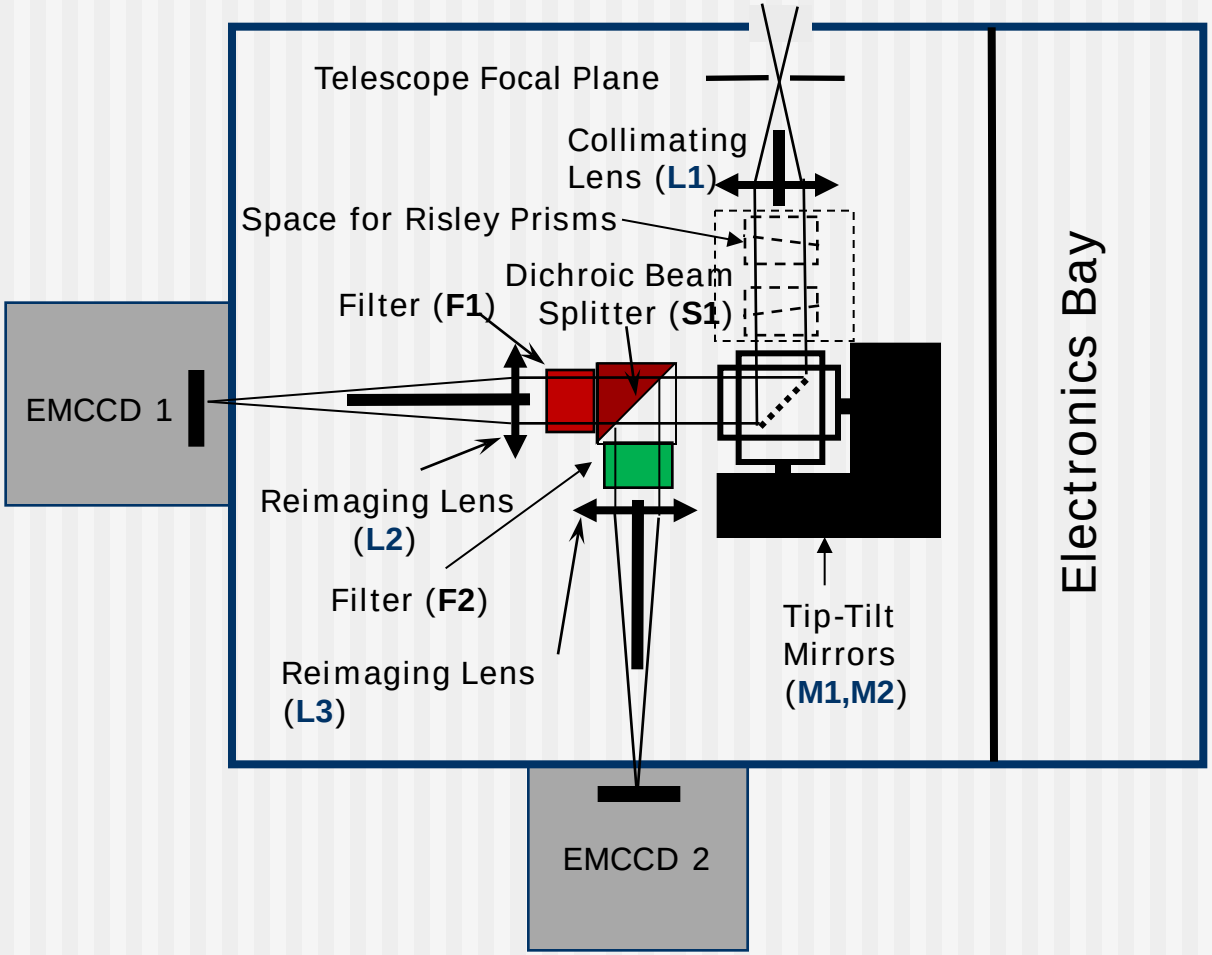




Collaborators

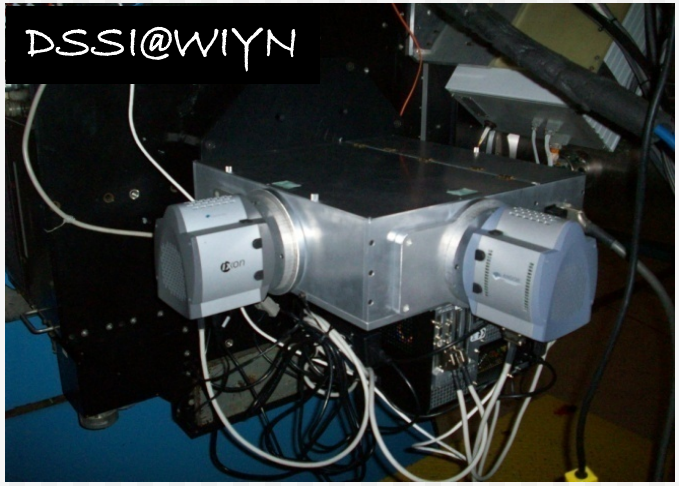
- Field Binary Survey
  - Bill van Altena (Yale U.)
- Kepler
  - Steve Howell (NASA)
  - Mark Everett (NOAO)
  - David Ciardi (Caltech)
- Cluster Binaries
  - Bob Mathieu (U. Wisconsin)
  - Aaron Geller (Northwestern U.)

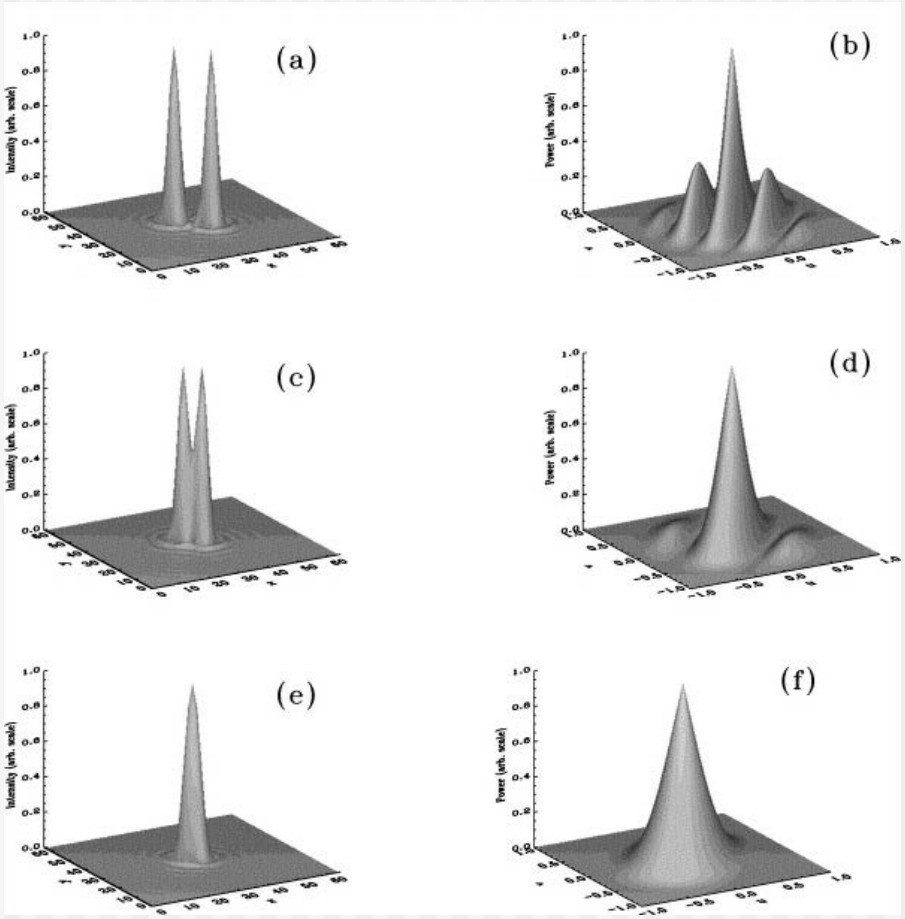
A Uniquely Capable Speckle Imager Built at SCSU



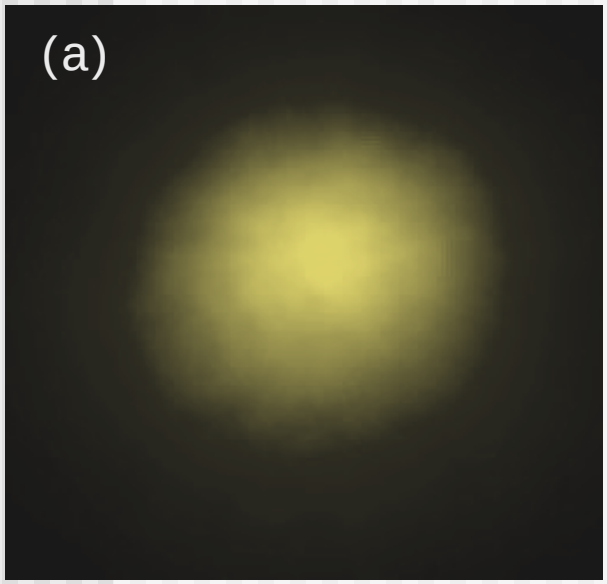
The Differential Speckle Survey Instrument (DSSI)

- Two channel EMCCD-based speckle camera, completed in August, 2008
- Observe two colors at the same time (dichroic beamsplitter inside).
- Differential refraction

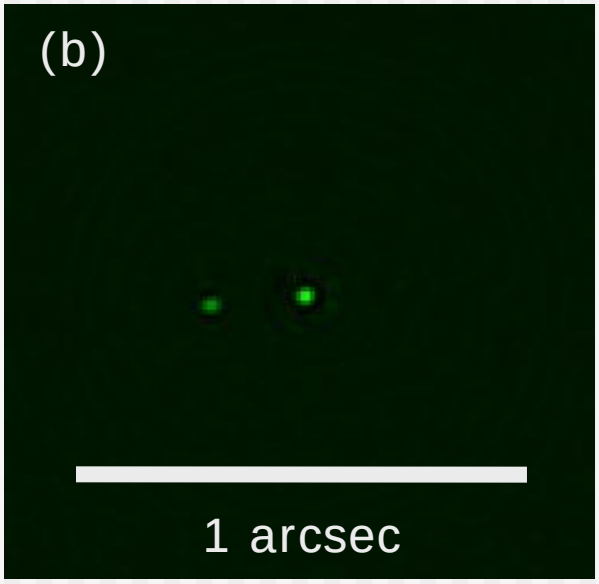




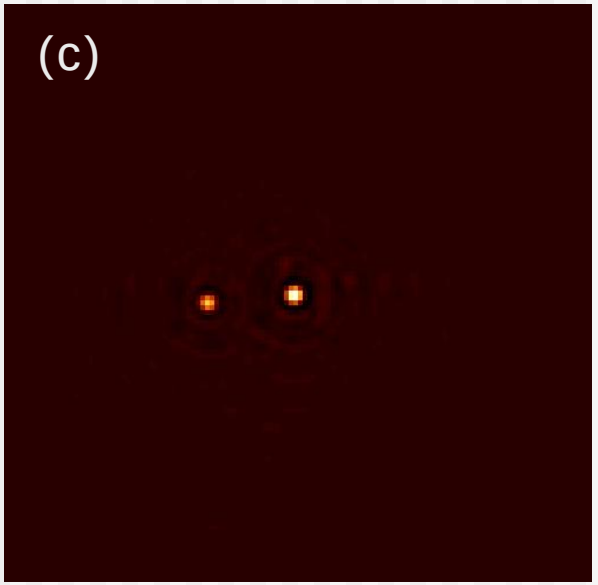
DSSI Result: A Binary Star



Panchromatic
Integrated Image



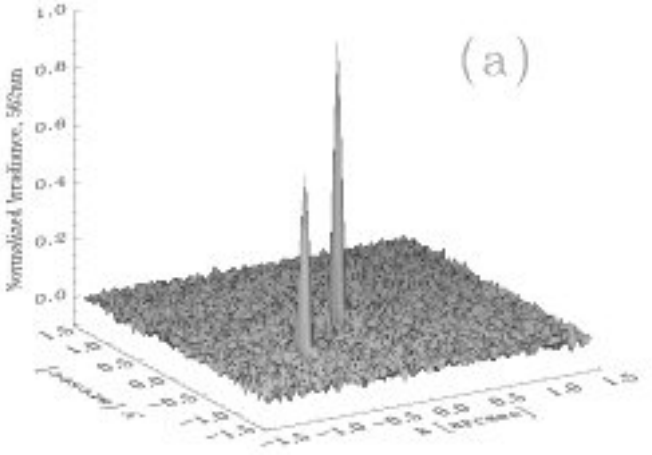
562 nm

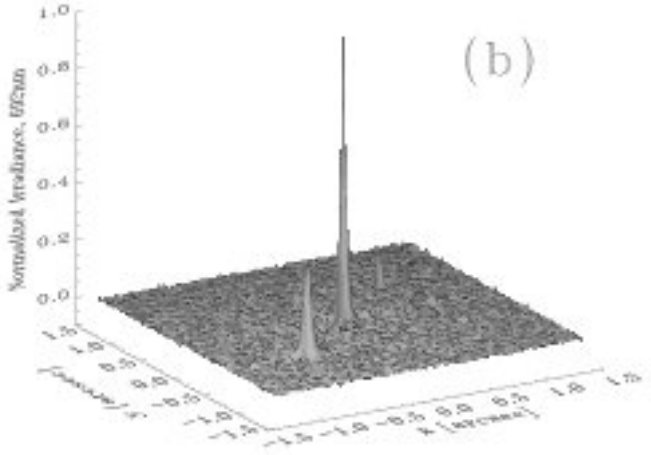


692 nm

Reconstructed Images

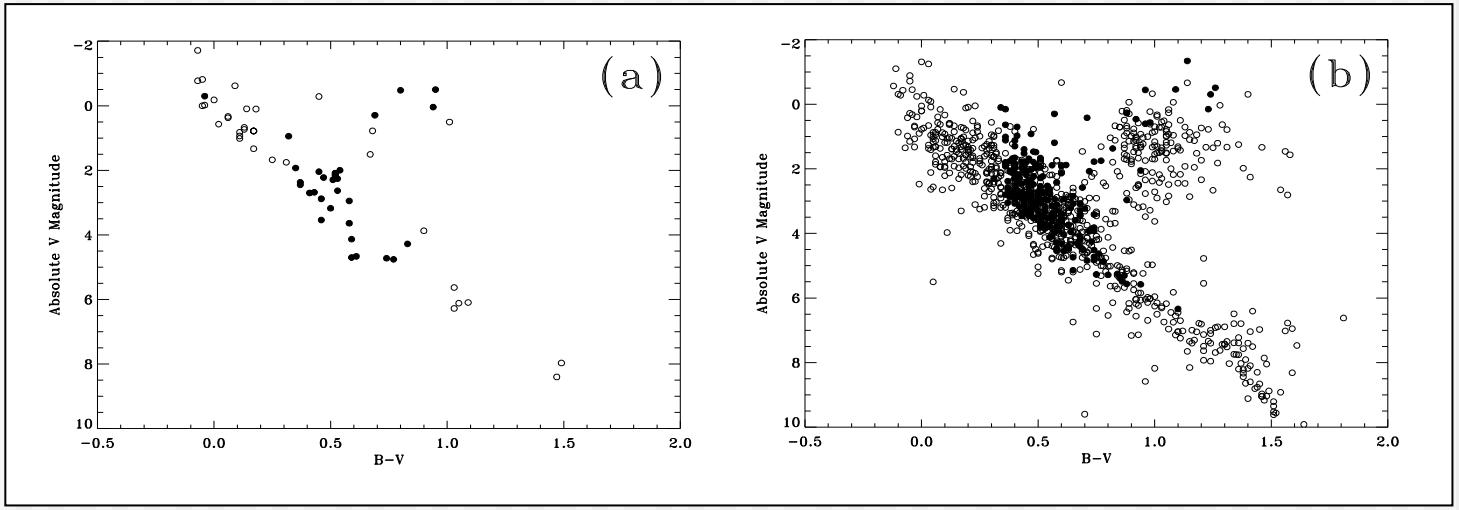
DSSI Result: LP439-387



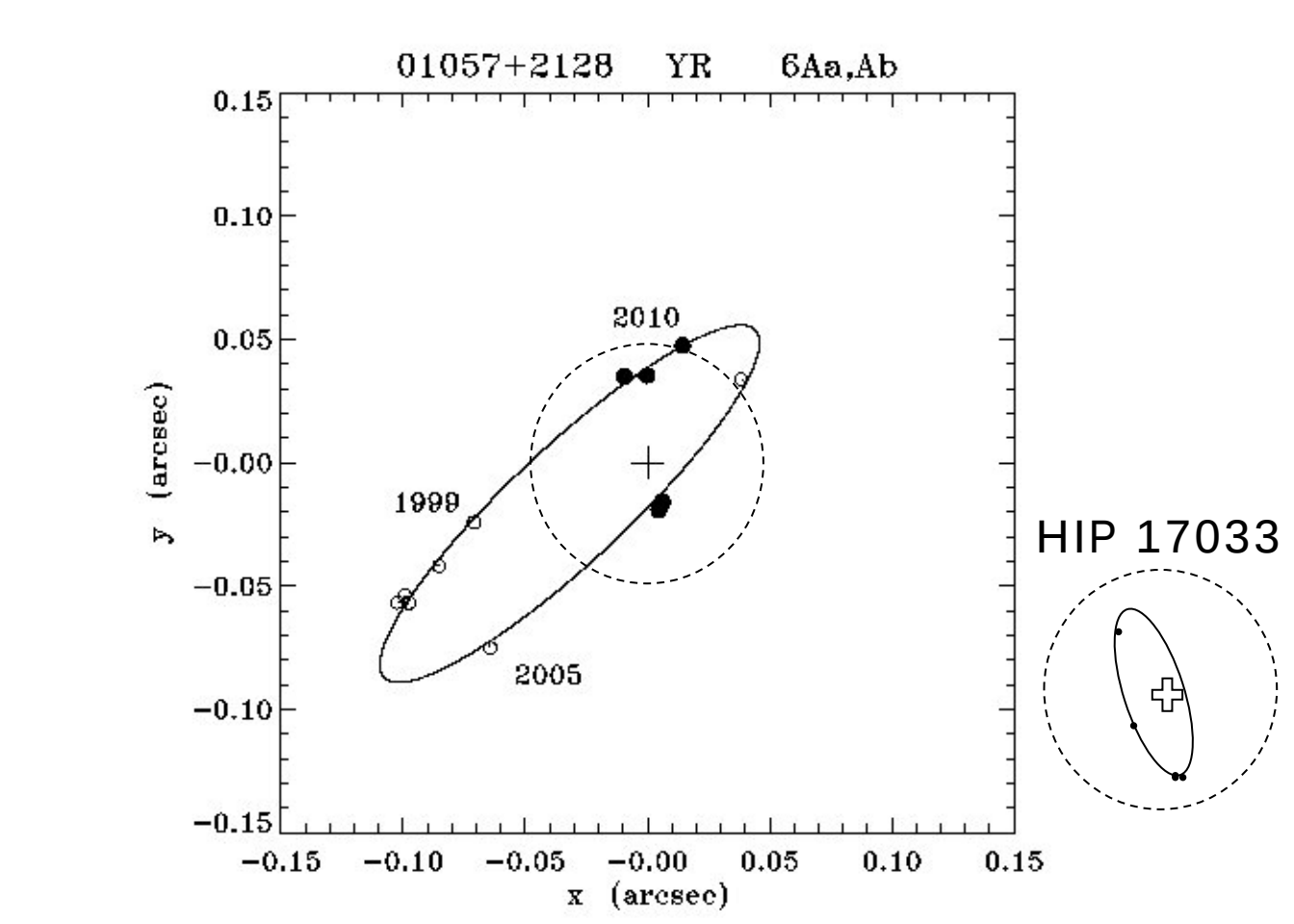


High Resolution Imaging and Binary Stars

- Stellar Masses
  - Resolve spectroscopic binaries for individual masses.
- Mass-Luminosity Relation (MLR)
- Statistics of binaries as clues to star formation and galactic evolution.
- NSF Grant to survey *Hipparcos* Double Stars

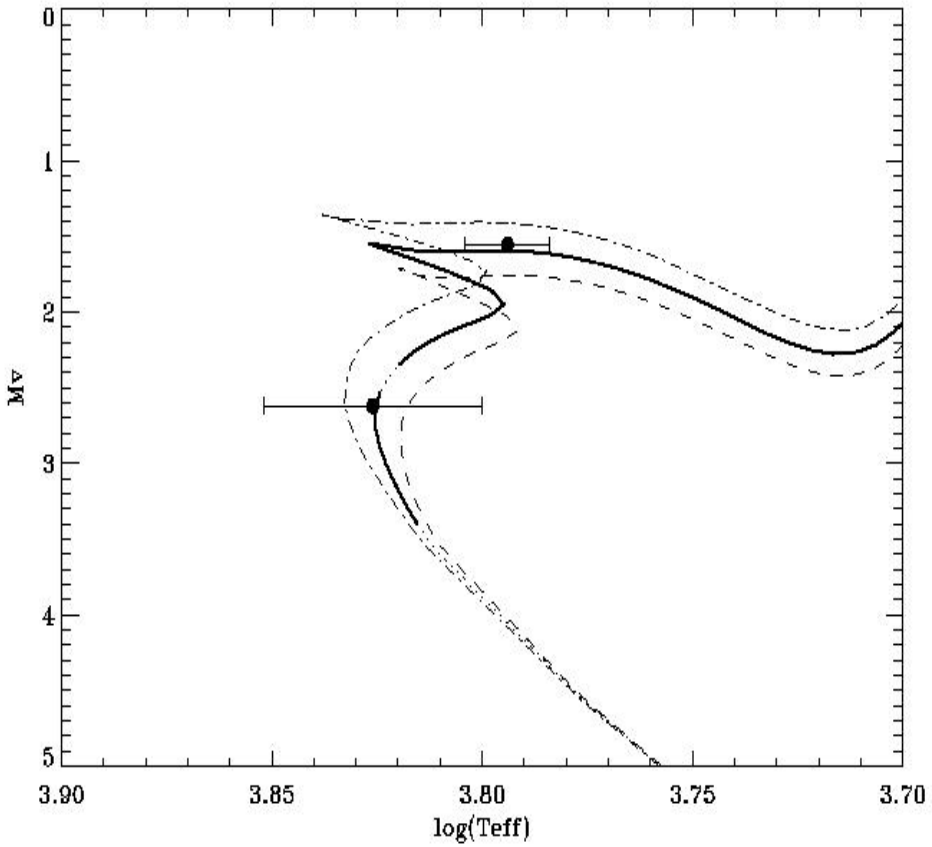


Science: Orbits and Masses

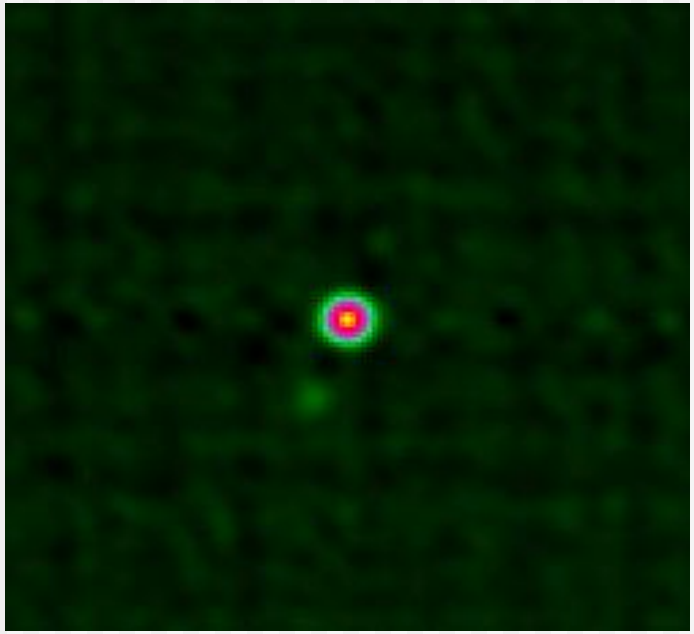


Science: Stellar Evolution

- H-R diagram with Y^2 isochrones at right.
- Speckle binaries with good magnitude/ color information of components can be excellent tests of stellar evolution.
- We are trying to make many plots like this.
- With evolved components, one can derive good ages.



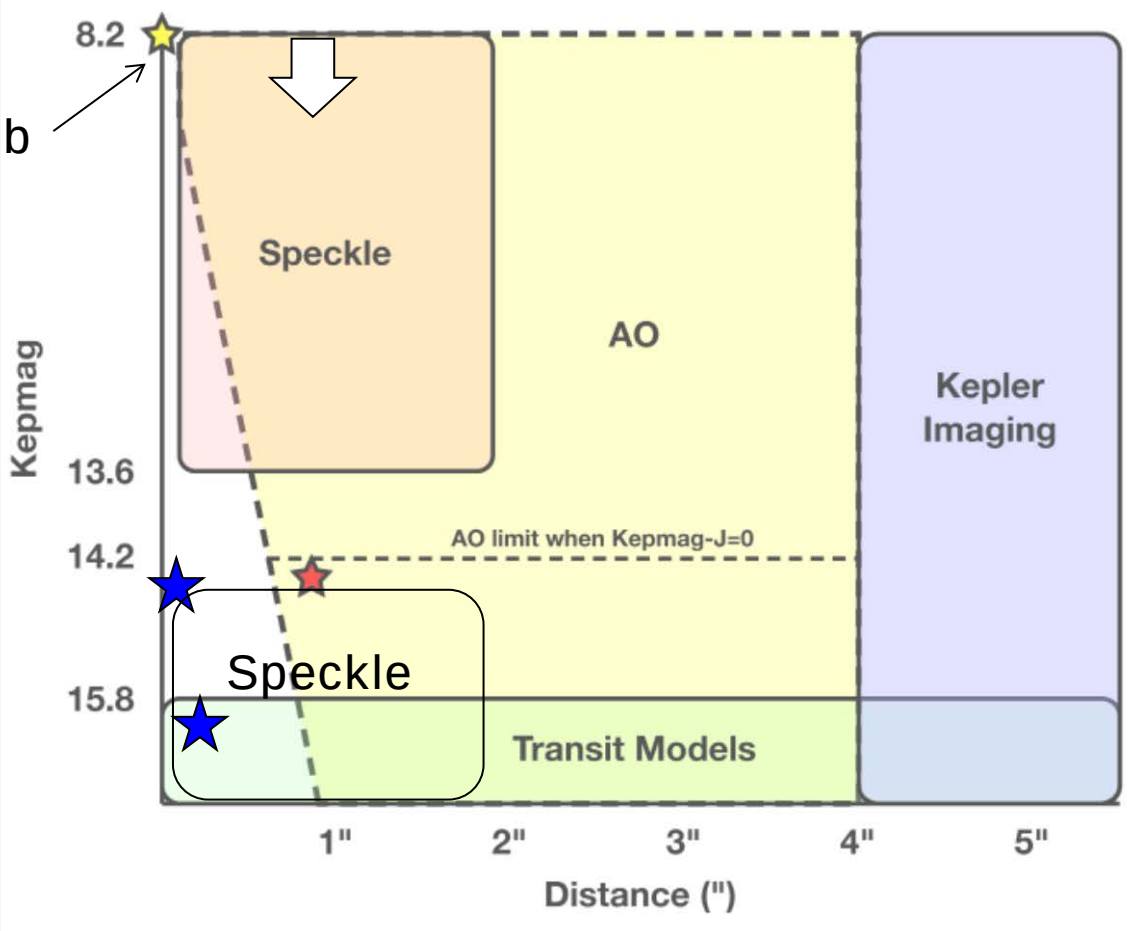
- We have done ground-based follow-up work for CoRoT and (mostly) Kepler.
- Kepler: about 12 nights of WIYN time per year.
- DSSI is helping to vet planetary candidates for binarity.
- Typical result: Kepler 22b.



14.3-mag star shown to be binary at WIYN.

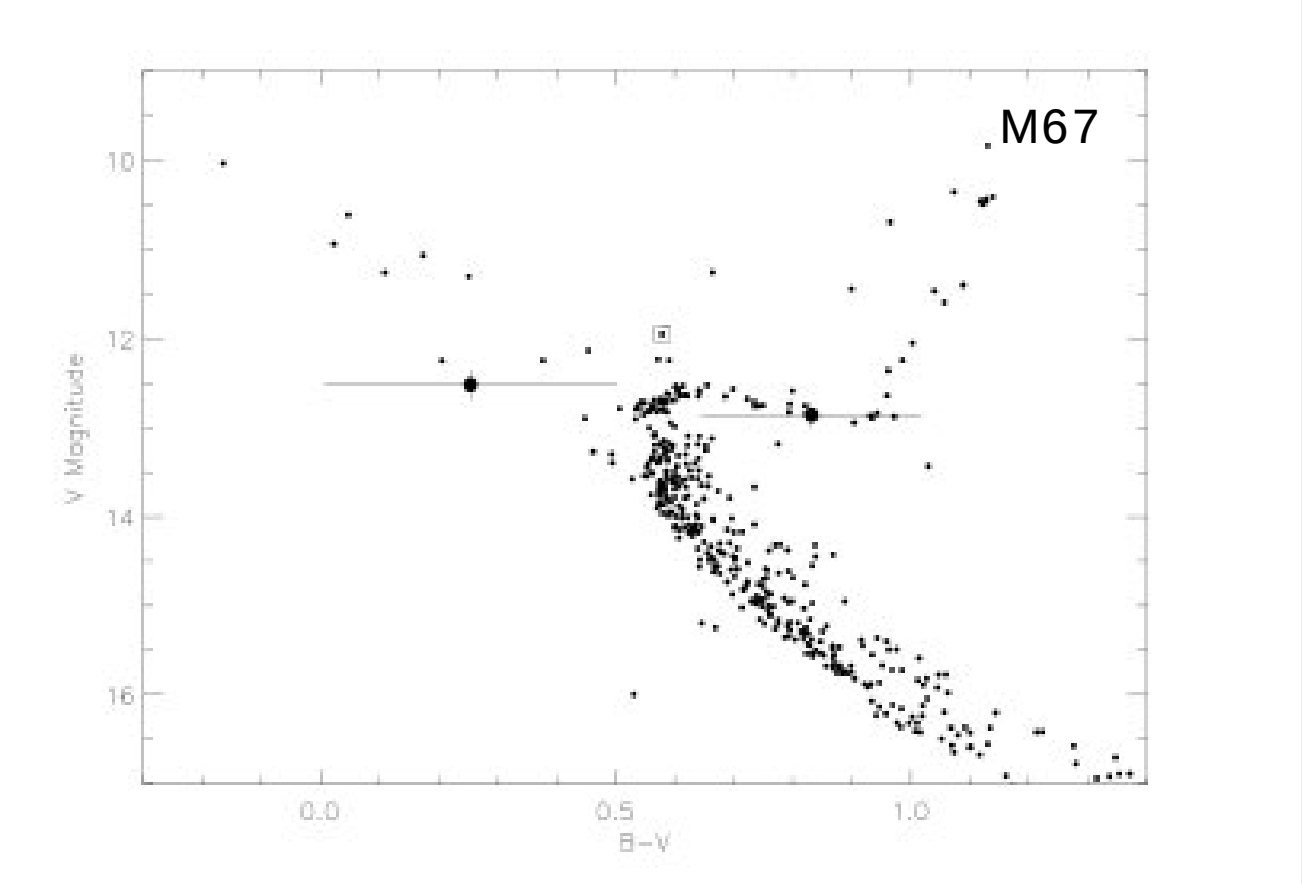
Kepler Follow-up Photometry

(Kepler 21b Host star)

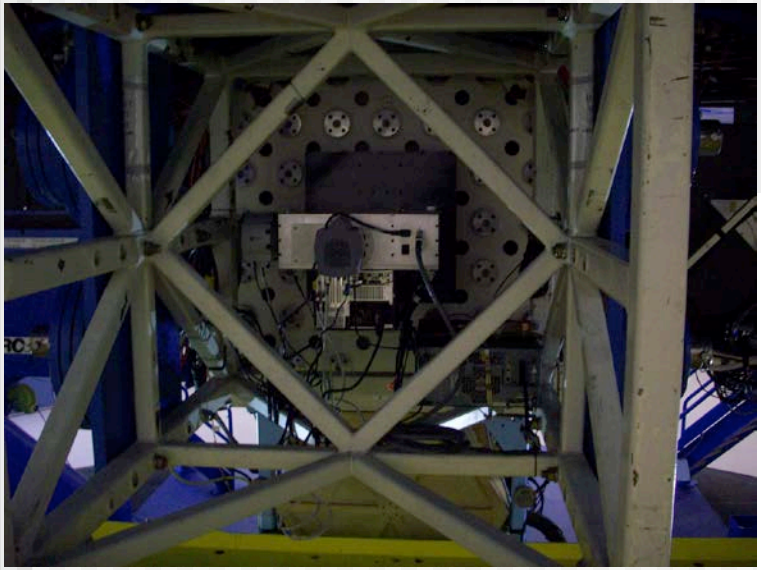


(Figure based on Howell et al.)

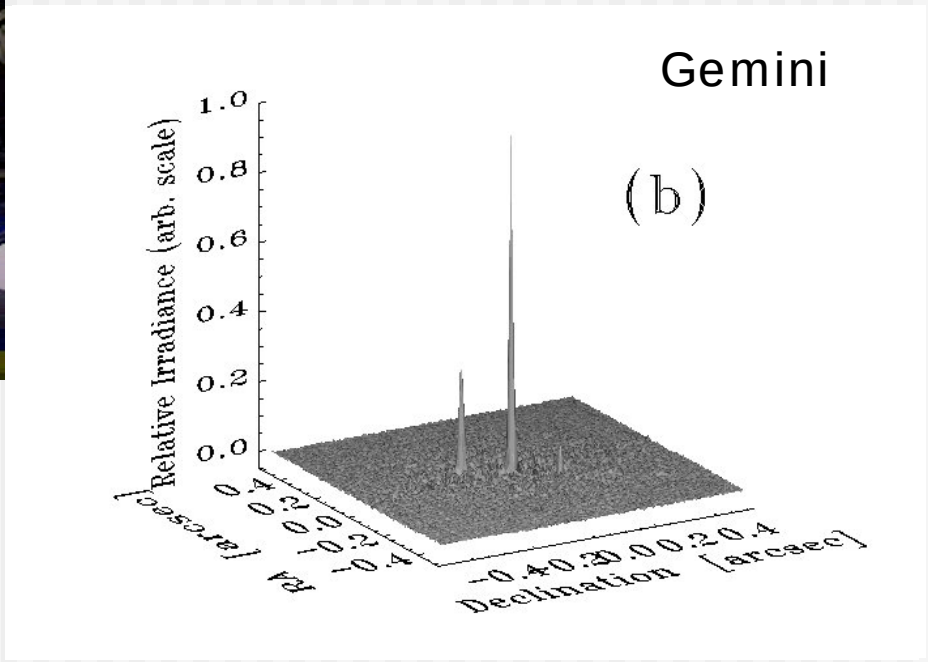
Cluster Binaries: Comparing M67 and M35



Gemini-N

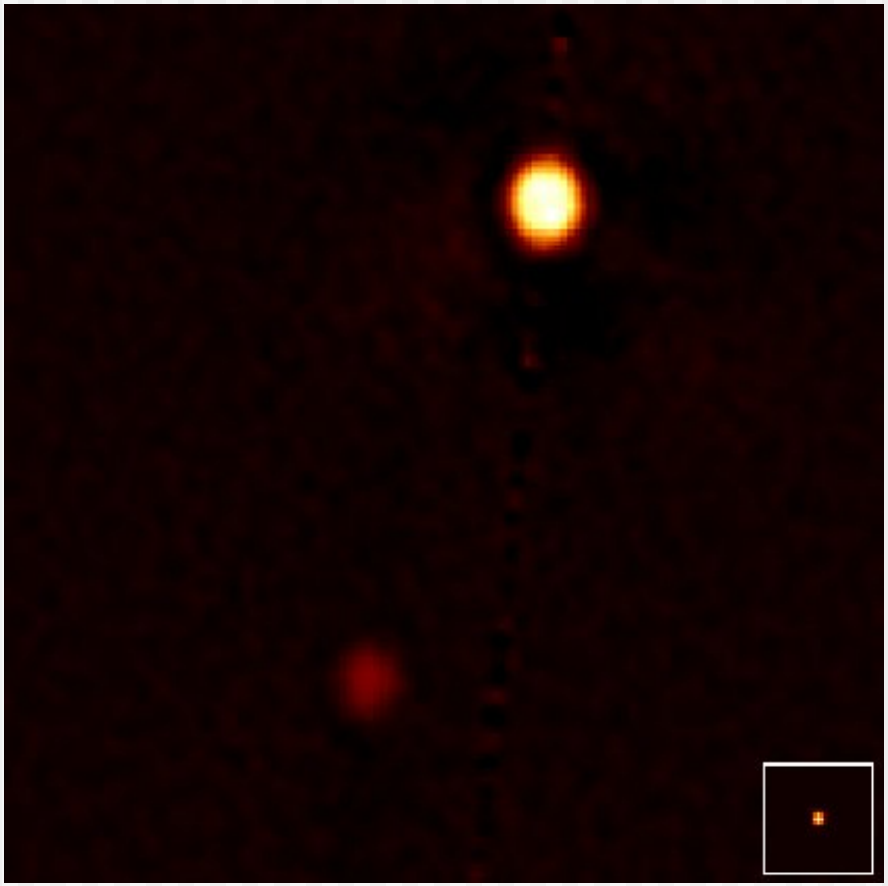


Used in July 2012



Gemini-N: Extended Objects

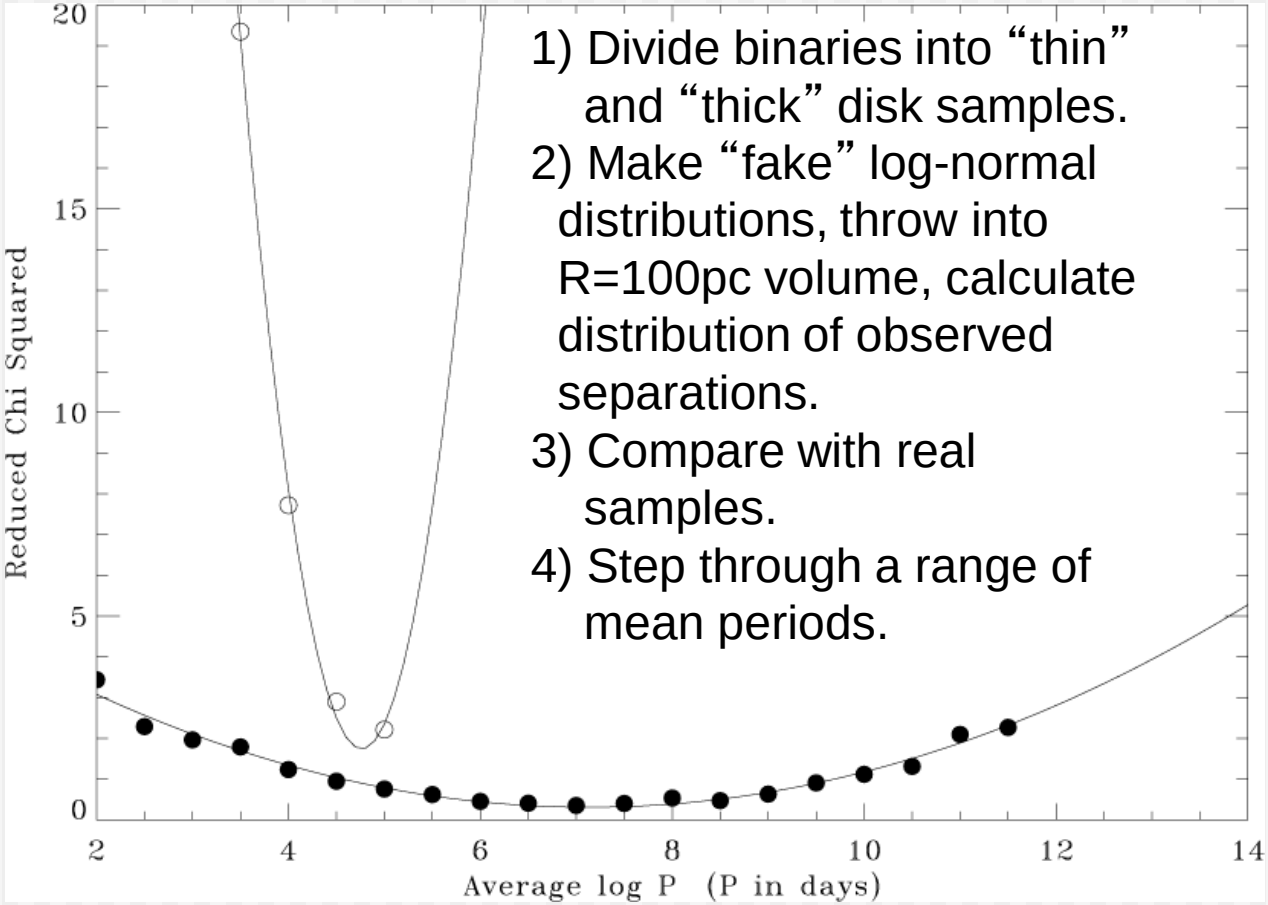
- Pluto/Charon
- ~30 minutes of observing time
- See Howell et al. in recent PASP issue.
- Measured radii.
- Working on better image reconstruction algorithms for future projects.



Conclusions

- DSSI is a dual channel speckle imaging system currently at WIYN
  - Limiting mag ~15 at V.
- Science:
  - Survey of Hipparcos double stars (nearly complete).
  - Kepler/CoRoT Follow-up.
  - Cluster binaries.
  - Better Image Reconstruction Algorithms
- Possible opportunity for Gemini-N observing next July.

A Modest Experiment with the Hipparcos Catalogue



1) Divide binaries into “thin” and “thick” disk samples.
2) Make “fake” log-normal distributions, throw into R=100pc volume, calculate distribution of observed separations.
3) Compare with real samples.
4) Step through a range of mean periods.