



Direct Detection of Exoplanets with the Gemini Planet Imager (GPI)

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Instrument Concept

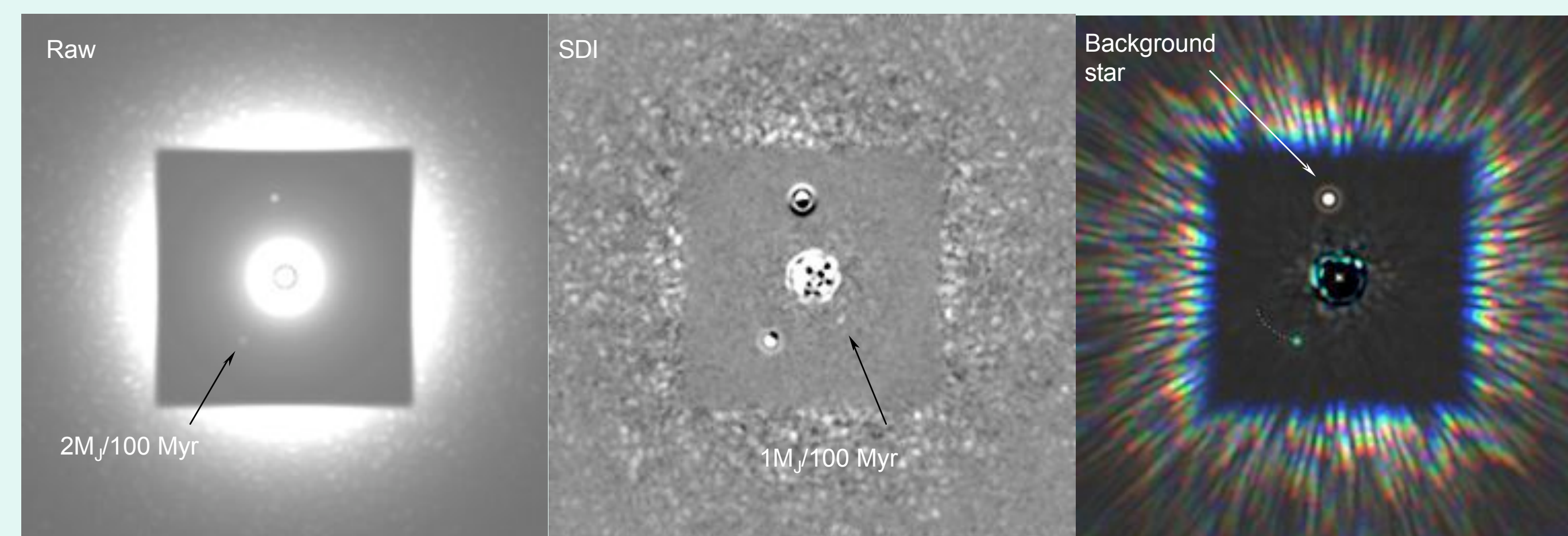
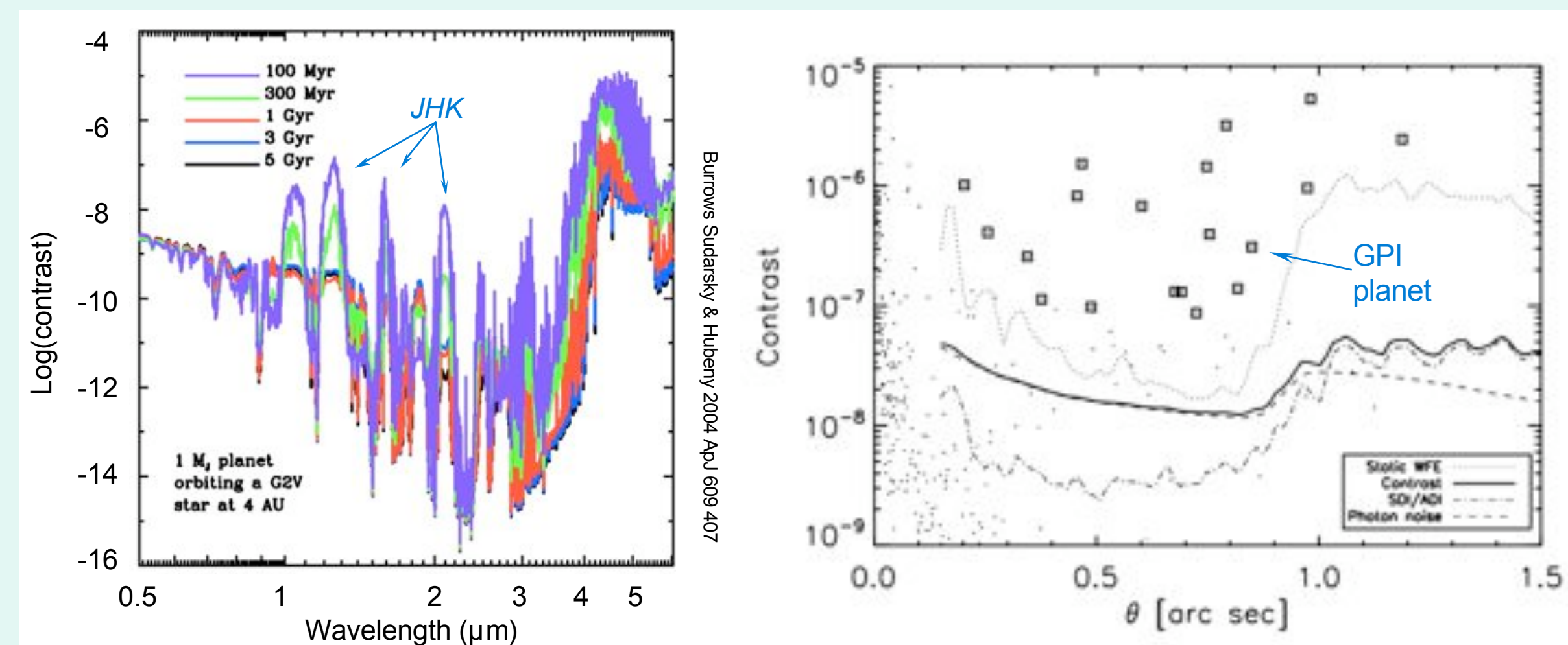
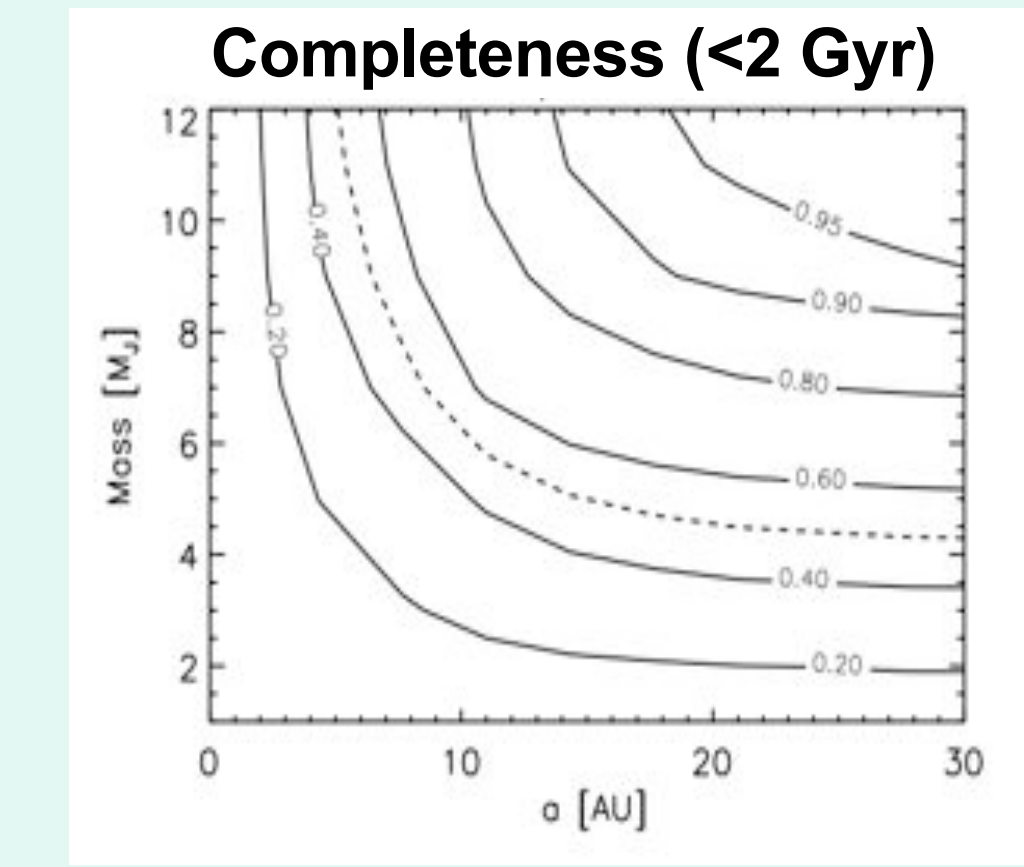
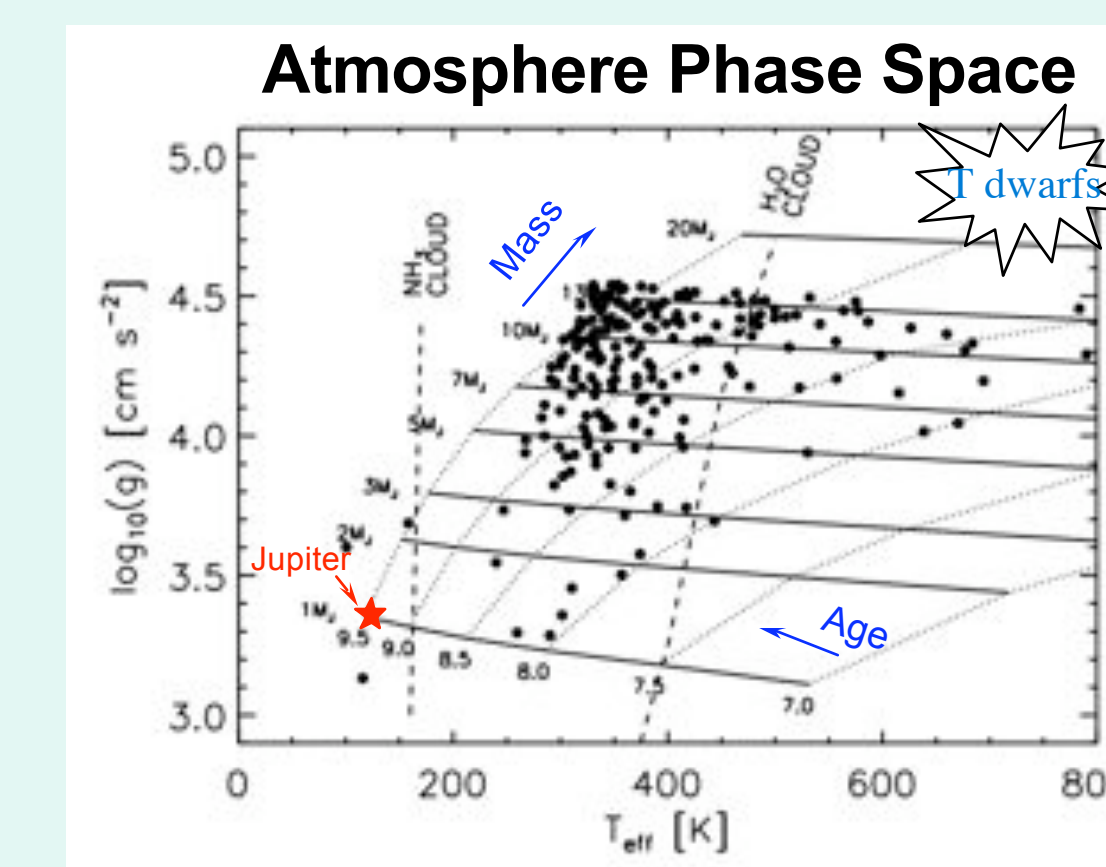
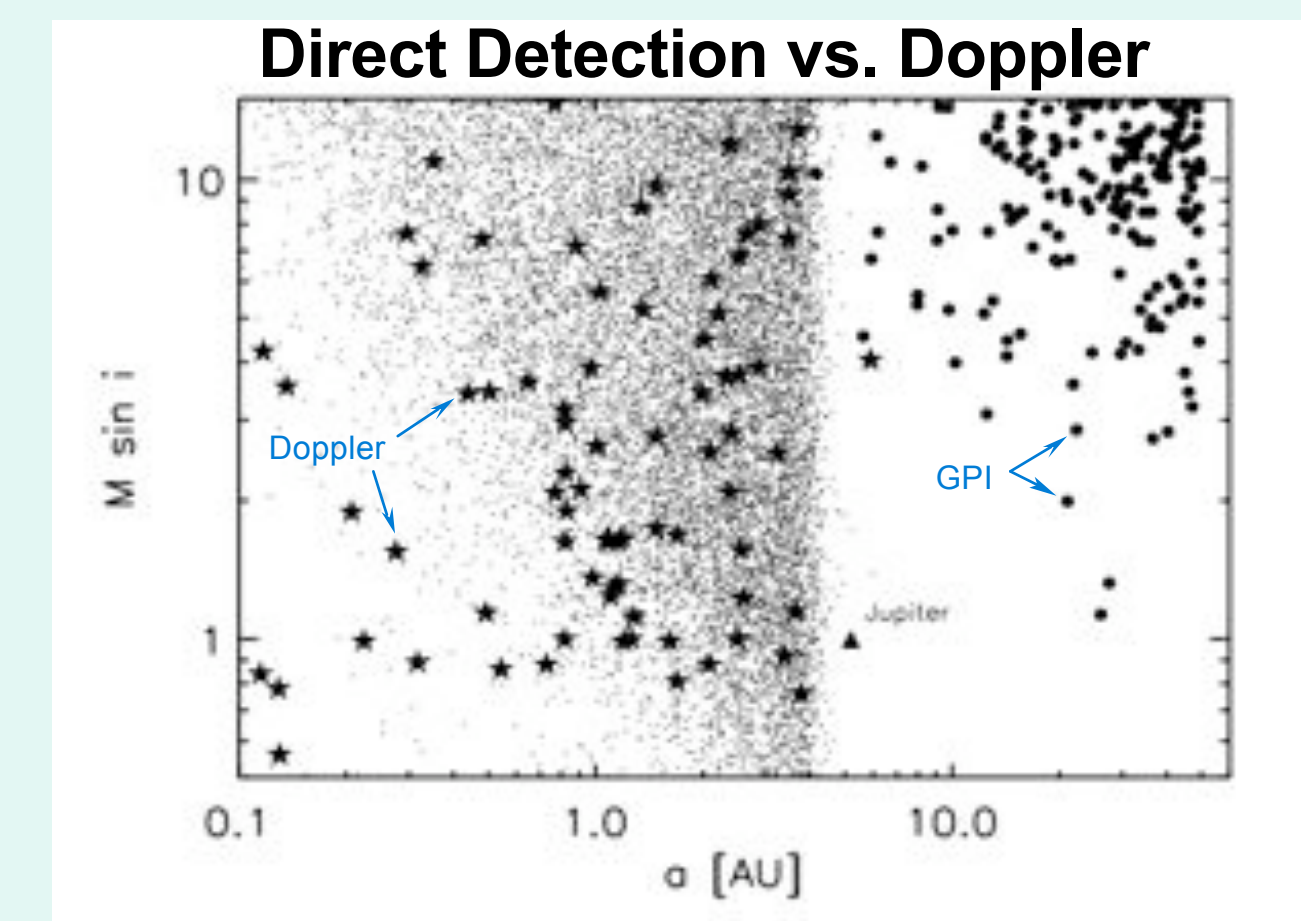
- Fast, high order adaptive optics
 - $I < 9$ mag. natural guide star
 - Dark hole diameter 1.8 arc sec at H
- Apodized pupil Lyot coronagraph
 - Inner working distance $\sim 4\lambda/D = 40$ mas @ H
- Interferometric wave front sensing
 - Real-time sensing of "static" aberrations at coronagraph spot
- Integral field spectrograph science instrument
- Post-processing speckle suppression
 - Angular differential imaging (ADI)
 - Spectral speckle nulling (SDI)
 - Polarization speckle nulling (PDI)

Core Science

- Direct detection of young, luminous planets
 - Luminosity history & planet formation mechanisms
- Exploration of jovian planet-forming zone
 - Map $5 < a/\text{AU} < 30$
 - Core accretion vs. gravitational instability
 - Complement Doppler & astrometry
- Spectroscopy of cool planetary atmospheres
 - $300 < T_{\text{eff}}/\text{K} < 500$ between H_2O & NH_3 condensation
- Debris disks
 - Occurrence, morphology & composition
- Small solar system bodies
 - Geomorphology & volcanism of icy moons
 - Asteroid moonlets

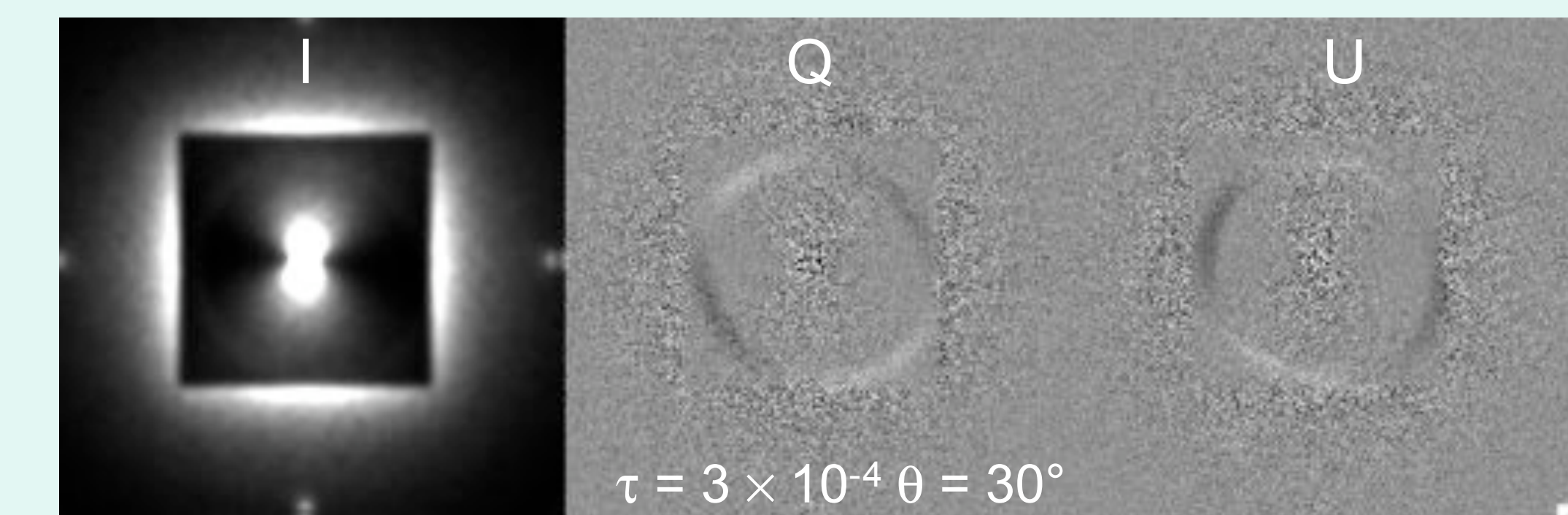
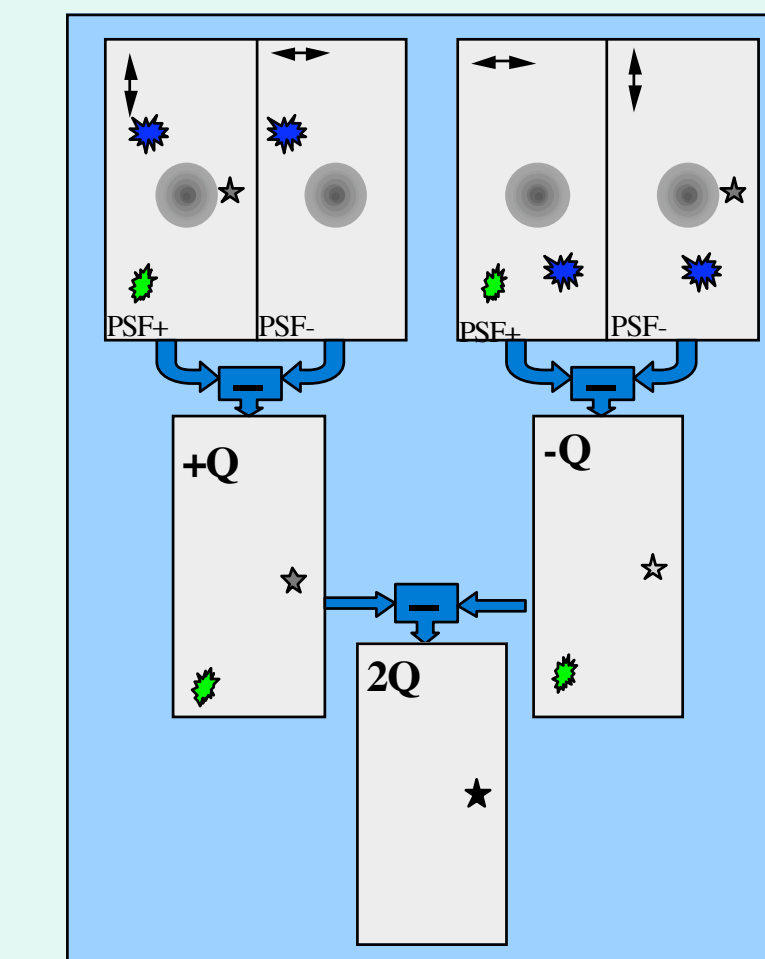
Experimental Design

- Exoplanet surveys simulated using Monte Carlo methods



Debris disks

- Polarimeter cancels stellar speckles
 - Detect Fomalhaut analog face-on

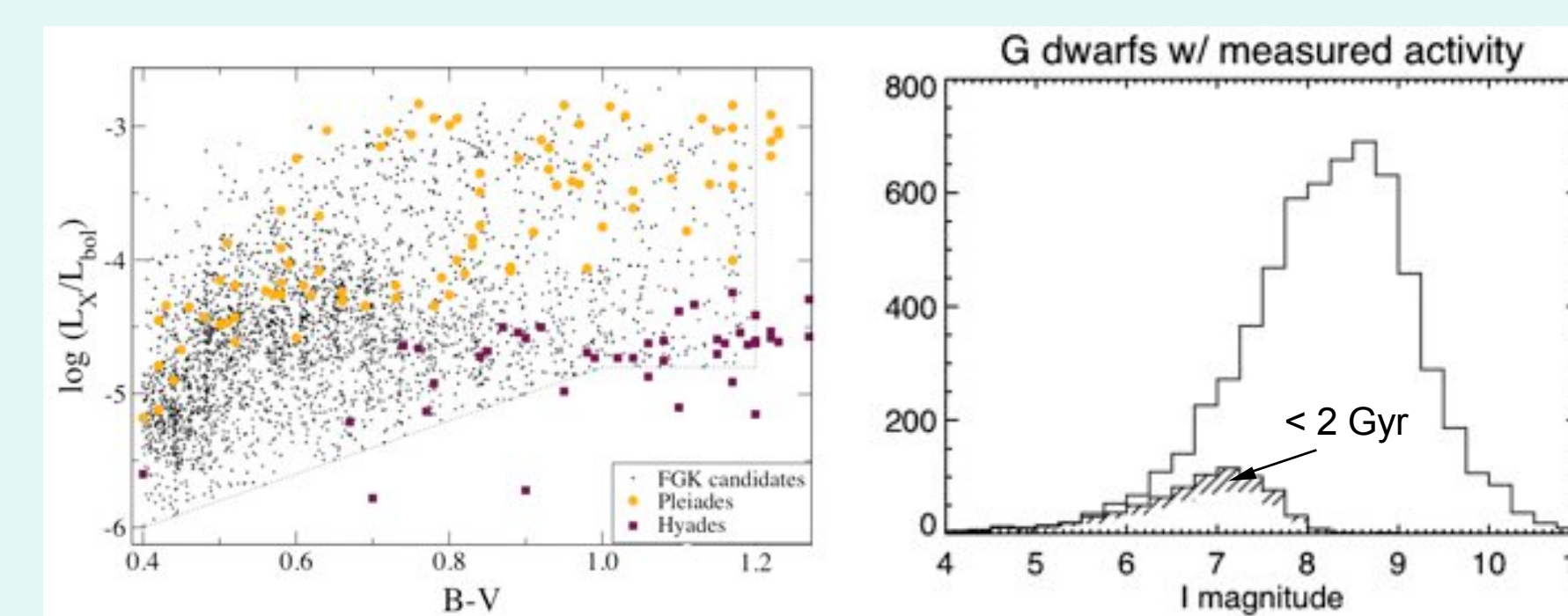


Instrument Capabilities

- High contrast imaging
 - $\sim 10^{-8}$, $1-\sigma$, 1-hour for bright targets
- Lenslet based integral field spectrograph
 - 2.8×2.8 arc sec field of view
 - Nyquist image sampling @ 14 mas per lenslet
 - Operation in $YJHK$
 - $R \approx 40$ spectroscopy @ H
 - Dual channel polarimeter (full field)
- Milli-arc second astrometry

Science Team Activities

- Observing scenarios & survey design
- Target selection
 - Young (< 100 Myr) stars
 - Adolescent (0.1–2 Gyr) FGK stars
 - 3052 X-ray bright Tycho-2 stars
 - Ages for K & M stars
 - Debris disks
- Development of adjunct science
 - Stellar binaries



GPI Surveys

	Stars	Nights	N vs. S‡
Young stars	200	20/10*	S
A-stars	200	20/10	N/S
Adolescent FGK	500	50/25	S
Volume limited	2000	200/45	N/S
Debris disks	500	50	N/S

*Follow up
 ‡Gemini N vs. S

Timeline

- Gemini Board selects GPI: Aug 2005
- Project kick-off: June 2006
- Preliminary design review: May 2007
- Critical design review: May 2008**
- Test & integration: Dec 2009–Nov 2010
- First light at Gemini South: Jan 2011

<http://gpi.berkeley.edu>