NEAT workshop

Science Case #3

Diversity of exoplanets : the case of young stars

After *The Search for and Characterization of Young Planets, white paper by C. Beichman et al. (Astro2010, arXiv:0902.2972)*

Incidence and properties of young planets

Many critical questions concerning the formation and early evolution of gas and ice giant planets suffer from a near-total lack of data about the properties of planets orbiting young stars.

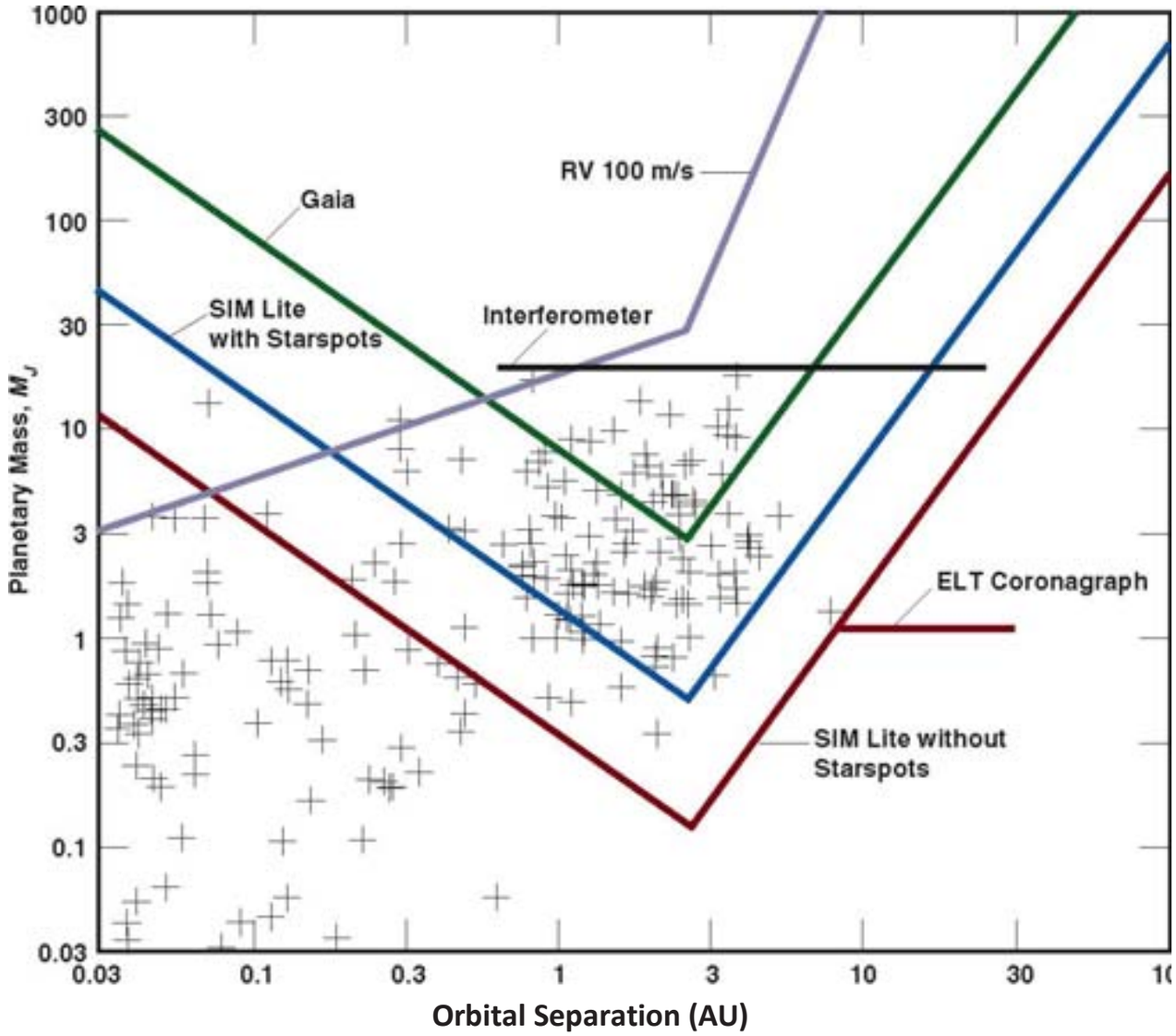
- What processes affect the formation and dynamical evolution of planets?
- When and where do planets form?
- What is the initial mass distribution of planetary systems around young stars?
- How might planets be destroyed?
- What is the origin of the eccentricity of planetary orbits?
- What is the origin of the apparent dearth of brown dwarf companions to mature stars?
- What accretion mechanisms might explain the apparent gap between the critical core mass and planets of Jupiter-Saturn mass?
- How might the formation and migration of gas-giant planets affect the formation of terrestrial planets?
- How do the observable properties of a planet change with its mass and evolve with time?

Requirements in terms of astrometry

Astrometric surveys of young stars will probe the critical region between 1-5 AU where gas giants are thought to form, but where imaging techniques are hardest pressed to detect objects of <5 MJup.

	1 *M* Star				0.15 *M* Star			
	Distance, pc				Distance, pc			
	30 pc		140 pc		30 pc		140 pc	
	Orbit, AU		Orbit, AU		Orbit, AU		Orbit, AU	
Planet	1	5.2	1	5.2	1	5.2	1	5.2
Jupiter, 1 *M*Jup	32	**170**	7	36	**214**	**1110**	46	**240**
Saturn, 0.28 *M*Jup	9	47	2	10	**60**	**311**	13	**67**
Uranus, 0.023 *M*Jup	0.7	4	0.2	0.8	5	26	1.1	6

Parameter space

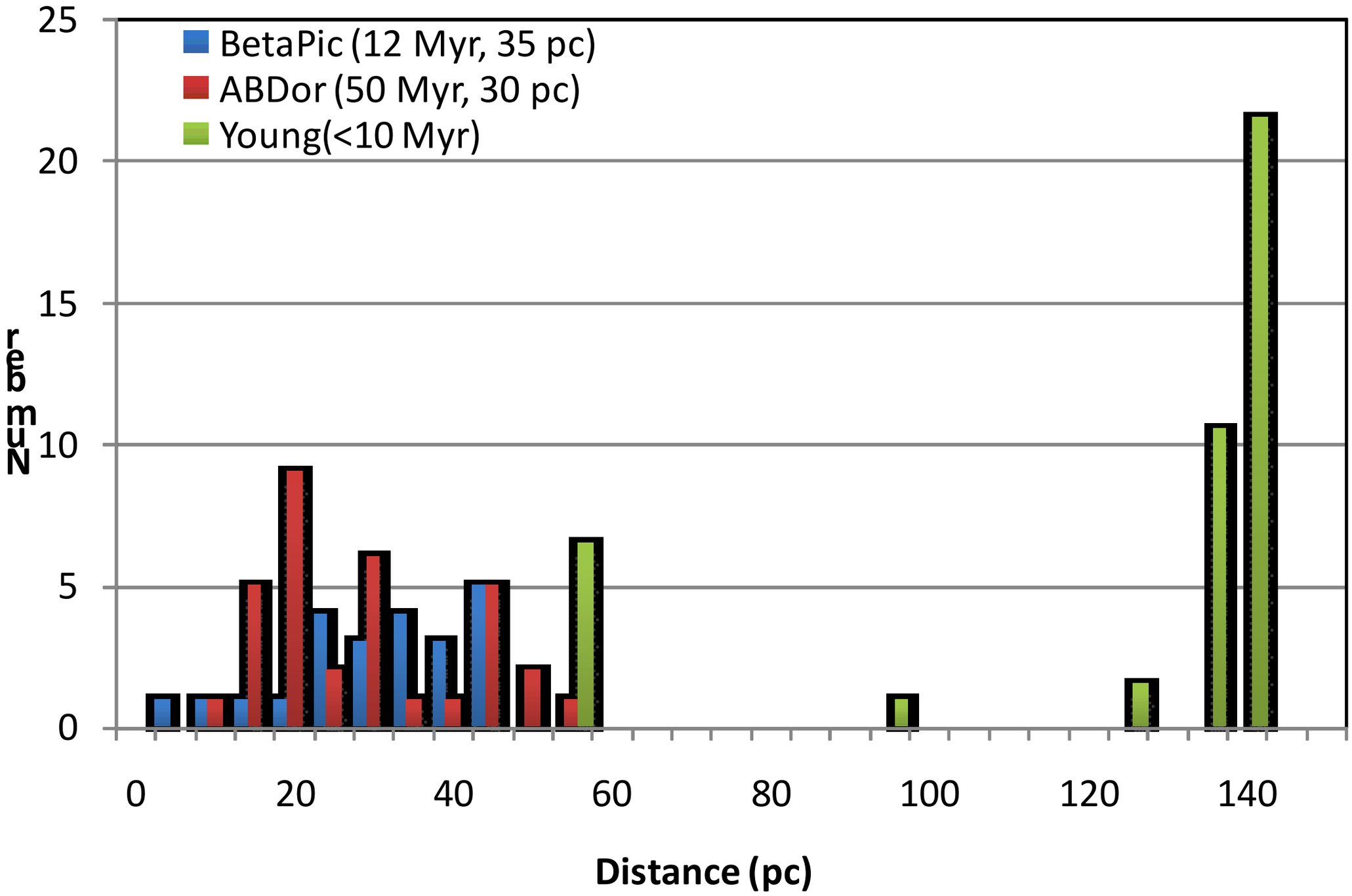


Sensitivity of different techniques to planets in the mass–semi-major axis plane for young 1Msun stars (<5 Myr) at a distance of 140 pc. A representative population of planets seen around nearby mature stars is shown to indicate what we might find when looking at young stars. SIM Lite sensitivity estimates are given for worst-case and best-case scenarios for starspot noise (Beichman et al. 2009)

Star spots on young stars?

- Using a simple model for the effect of starspots on the stellar photocenter (Beichman 2001; Tanner et al. 2007), the astrometric jitter for a typical T Tauri star at 140 pc is less than 3 μas (1σ) for R-band variability less than 0.05 mag.
- Thus, the search for Jovian planets is plausible for young stars less variable than ~0.05 mag in the visible. If stellar jitter follows the $t^{-0.5}$ dependence seen for calcium plage activity (Skumanich 1972) then a 40-Myr-old, 0.15 Msun star
- at a distance of 30 pc would have an astrometric jitter at <0.5 μas making planets of super- Earth to Uranus masses detectable over the semi-major axis range of 1 to 5 AU.

Potential Targets for Young Star Survey



+ Hyades cluster