Searching for Additional KBO Flyby Targets for the New Horizons Pluto/KBO Mission

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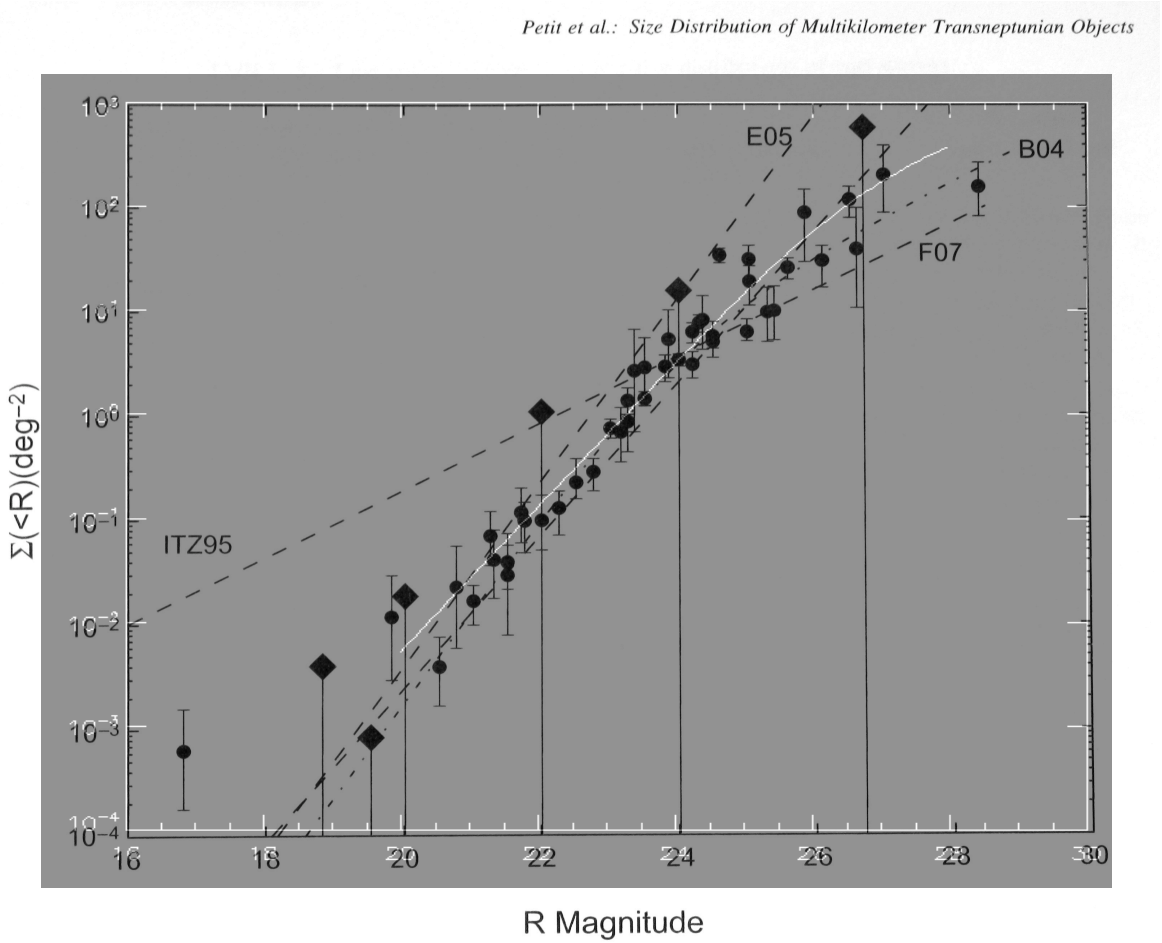
Number of accessible KBOs

- Model assumptions
  - Petit et al. (2007) magnitude/frequency distribution
  - Morbidelli and Brown (2002) radial distribution
  - Trujillo et al. (2001) latitude distribution
  - Size-frequency distribution is distance-independent

Comparison of model to observations

- Petit et al. (2007)
- White line is our model



Number of accessible KBOs

- Subject to further refinement…

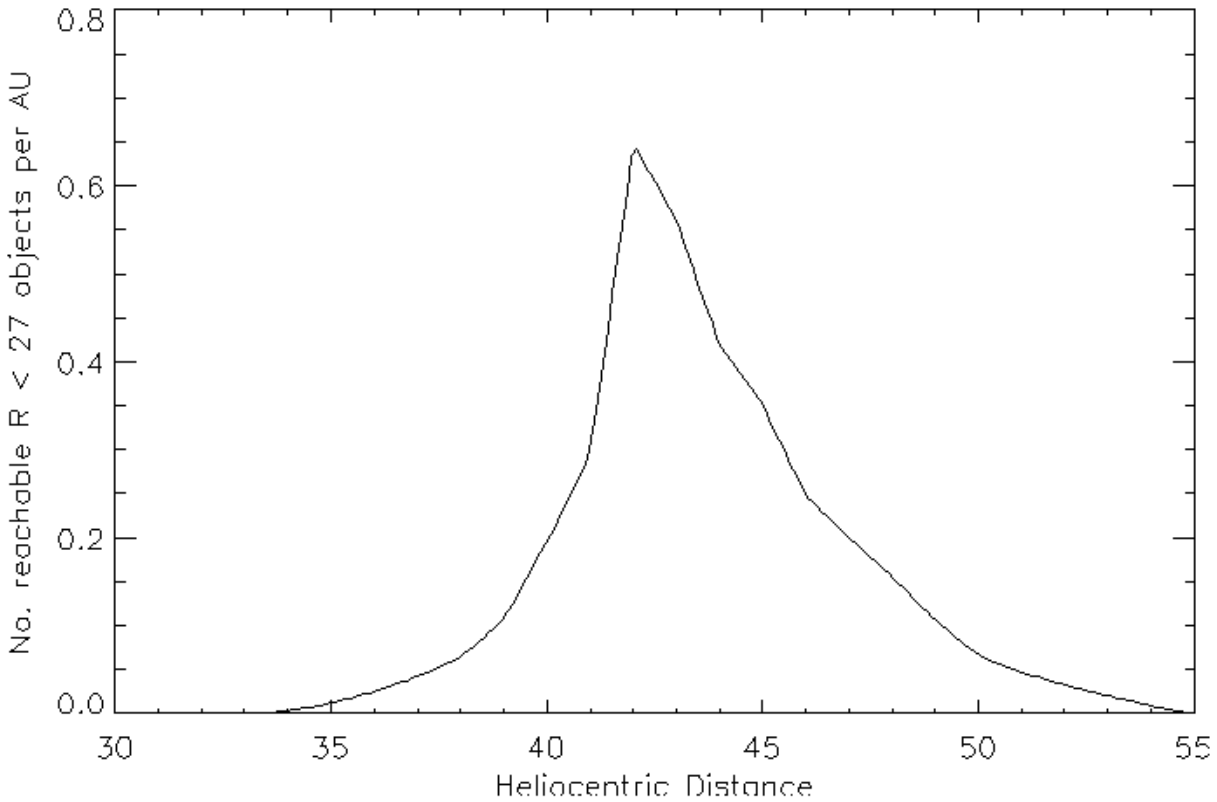
	KBO Diameter, km, 42 AU		
Limiting R Magnitude	p=0.04	p=0.08	Number accessible, 160 m/sec delta-V
24	>160	>92	0.1
25	>101	>58	0.5
26	>64	>37	2.1
27	>40	>23	7.0

Radial Distribution of Accessible KBOs

Strong peak at 42 AU, due to

1. Intrinsic peak there
2. Narrow cone at smaller distances
3. Faintness of more distant KBOs

Encounter probability peaks in early 2019 (nominal trajectory)

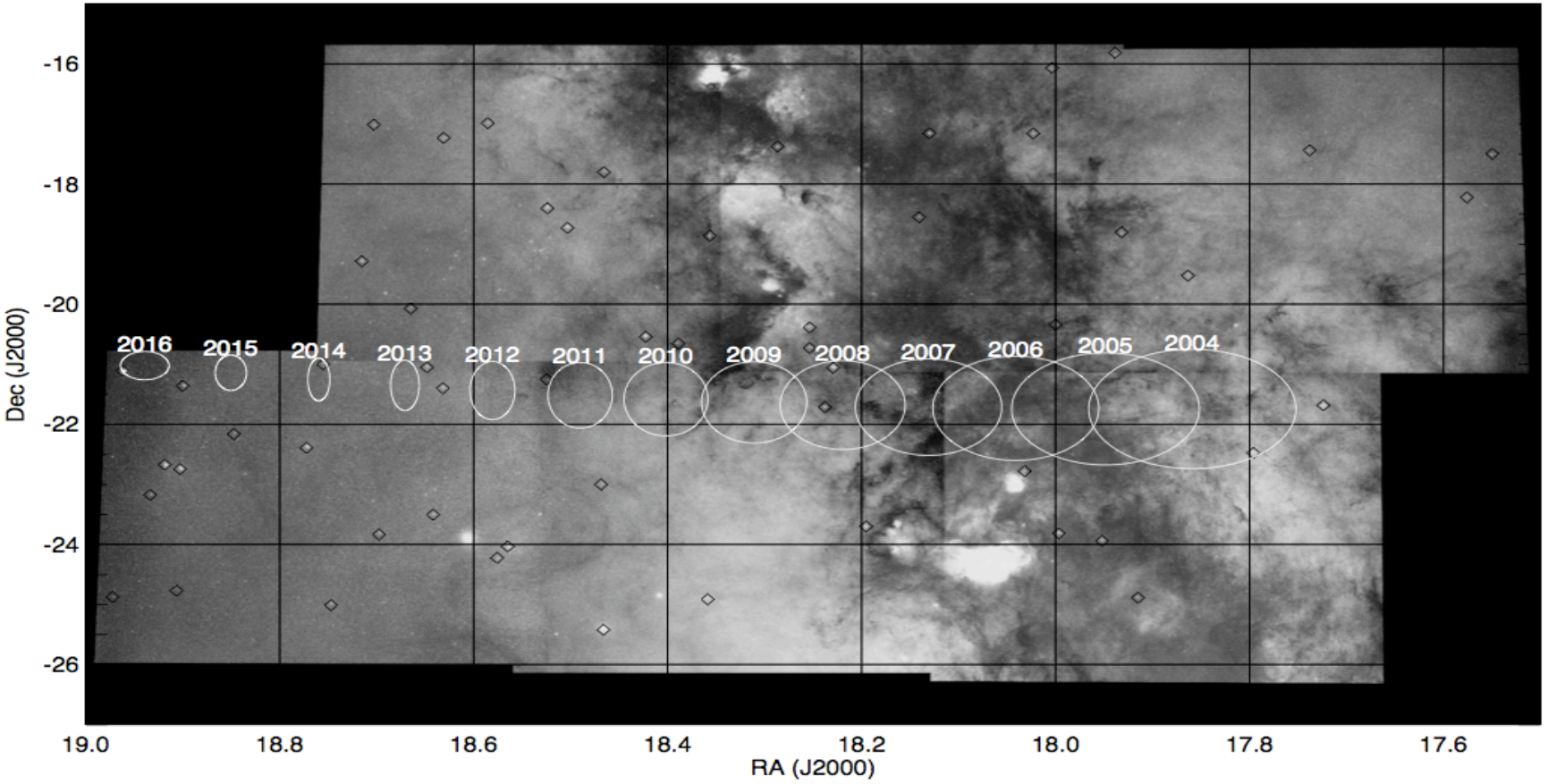


Search Strategy

1. Preliminary pre-launch search

2. Deeper search starting in 2011
   - Search area is smaller (accessible objects converge on the New Horizons trajectory)
   - Wider-field cameras available
   - Still time for orbit determination before Pluto flyby

Search Area (1-sigma)



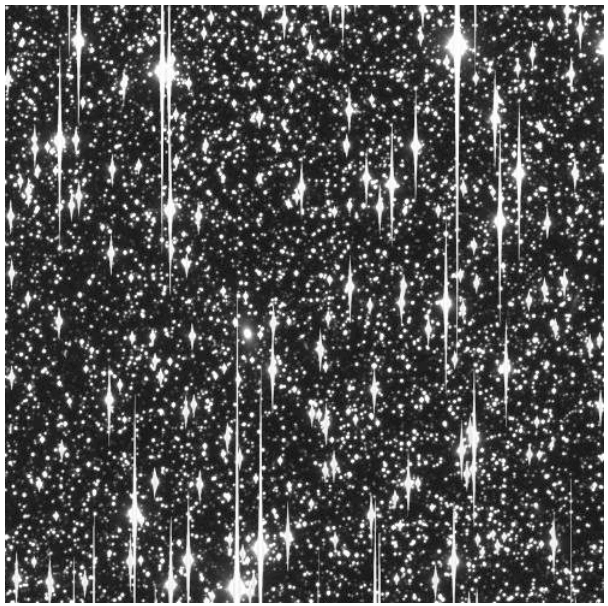
Background: Mosaic of POSS frames

Pre-Launch Search, 2004-2005

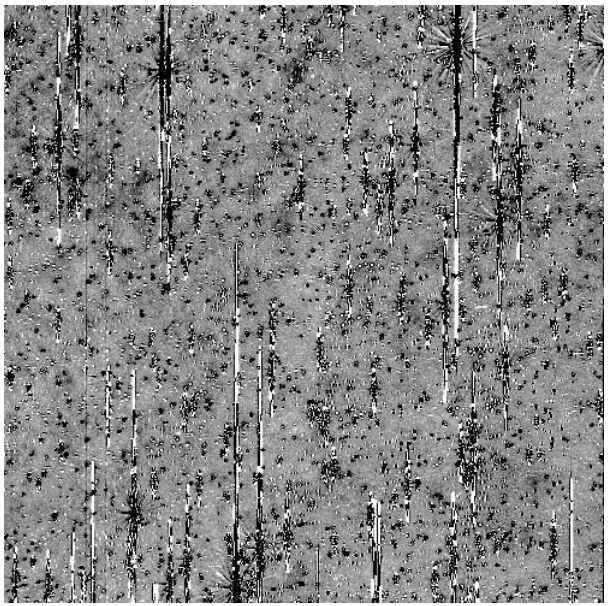
- Collaboration with the Subaru Telescope (Hiroshi Karoji (Director), Tetsuharu Fuse, Toshifumi Yanagisawa, Hisanori Furusawa, Daisuke Kinoshita, Fumi Yoshida et al.) and Dave Tholen, U. Hawaii
- Subaru 8-m telescope, SuprimeCam 0.25 deg^2 imager

Search Strategies

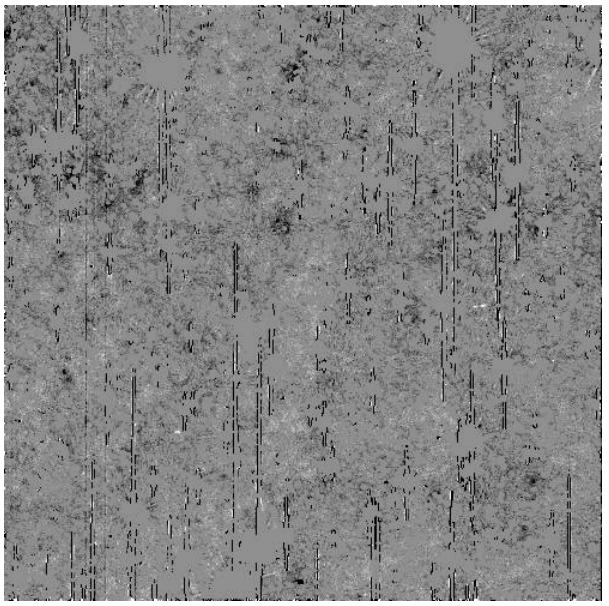
- Yanagisawa method



Median of 5 frames (moving objects removed)



Median subtracted from single frame

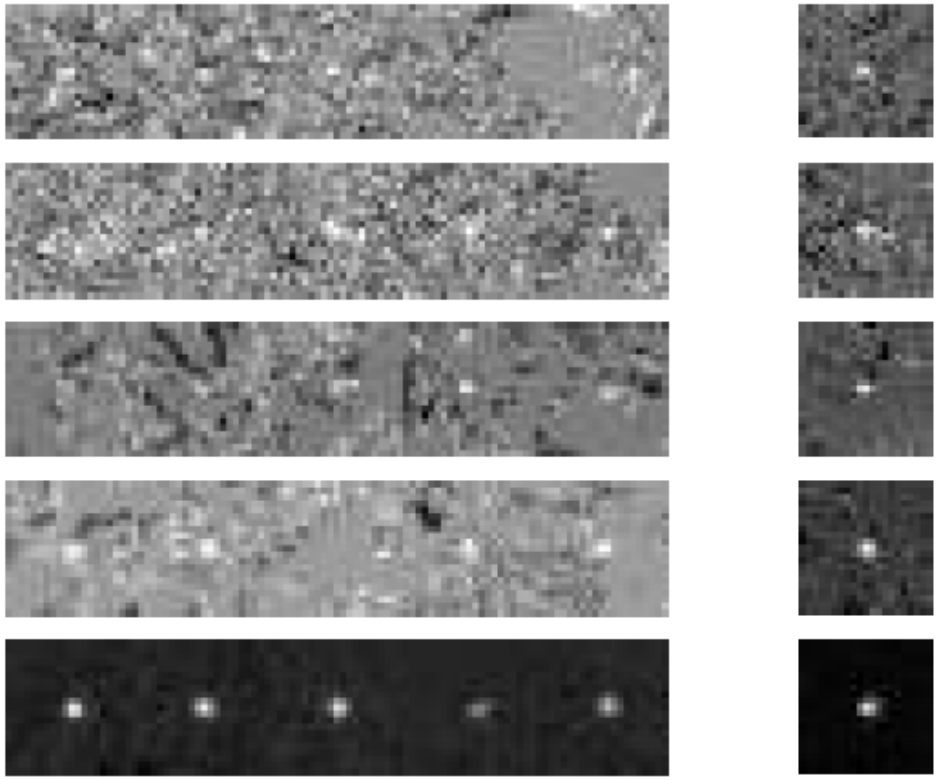


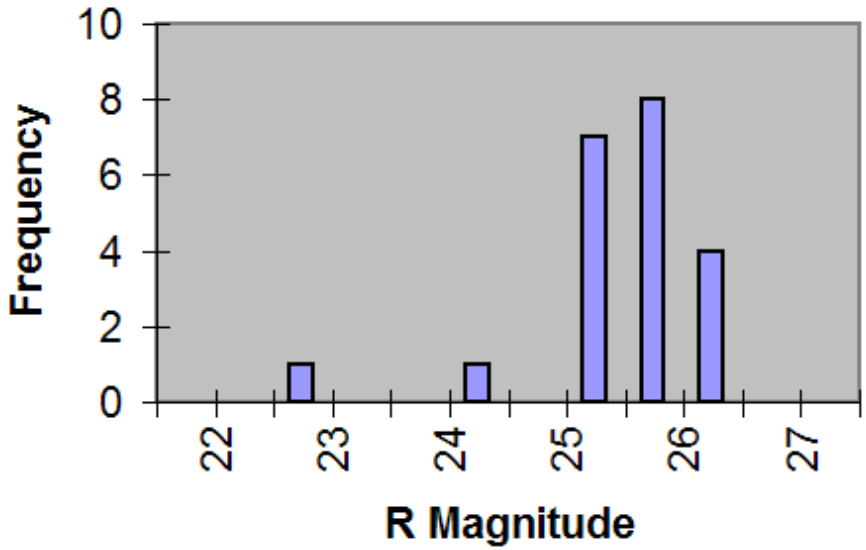
Residual stars masked out

Automated search for moving objects on the masked difference frames

Yanagisawa Discoveries

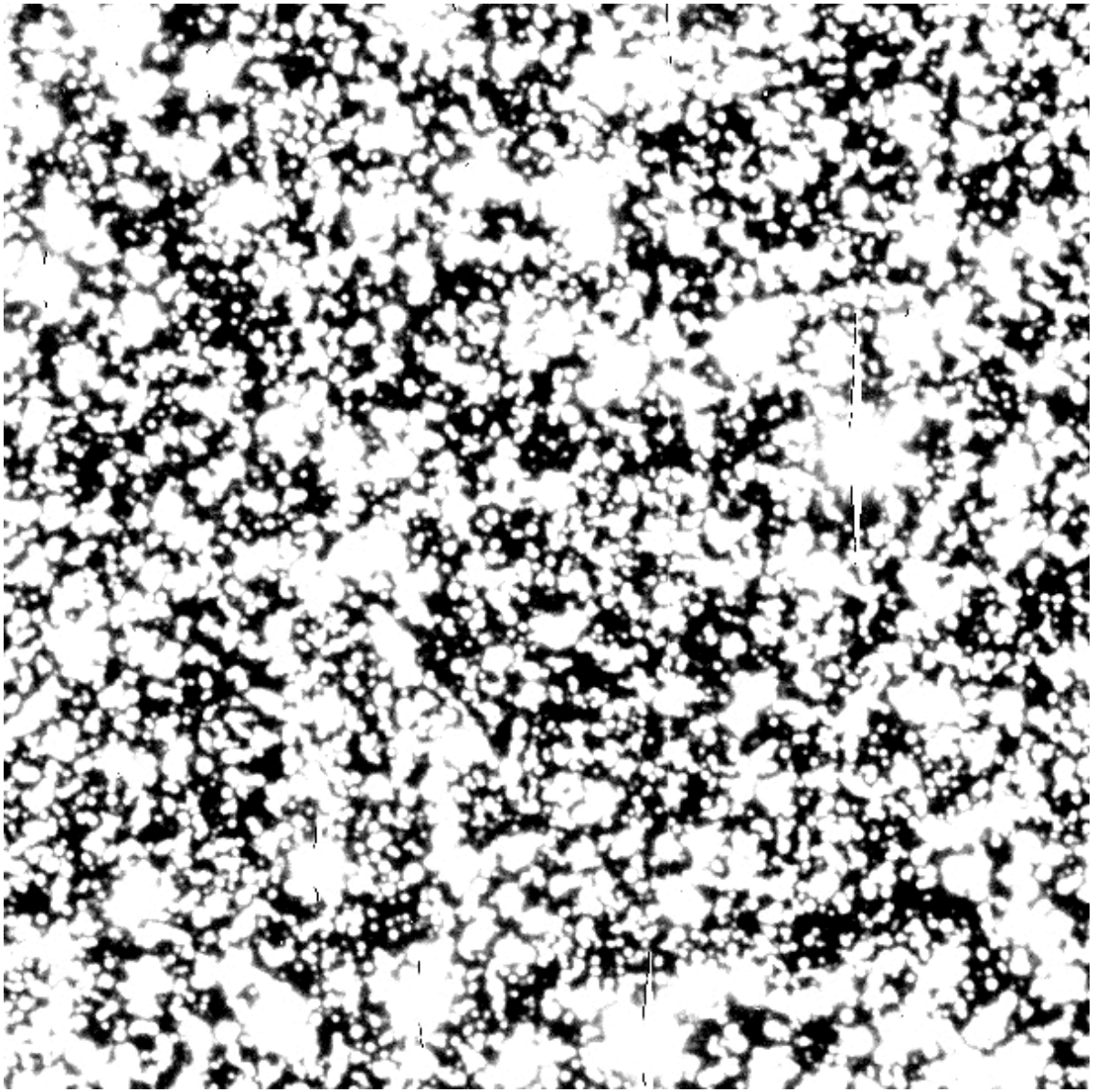
- 21 objects found by standard techniques in 4.5 deg^2
- Mostly in the dark clouds
- Limiting magnitude ~25.7?





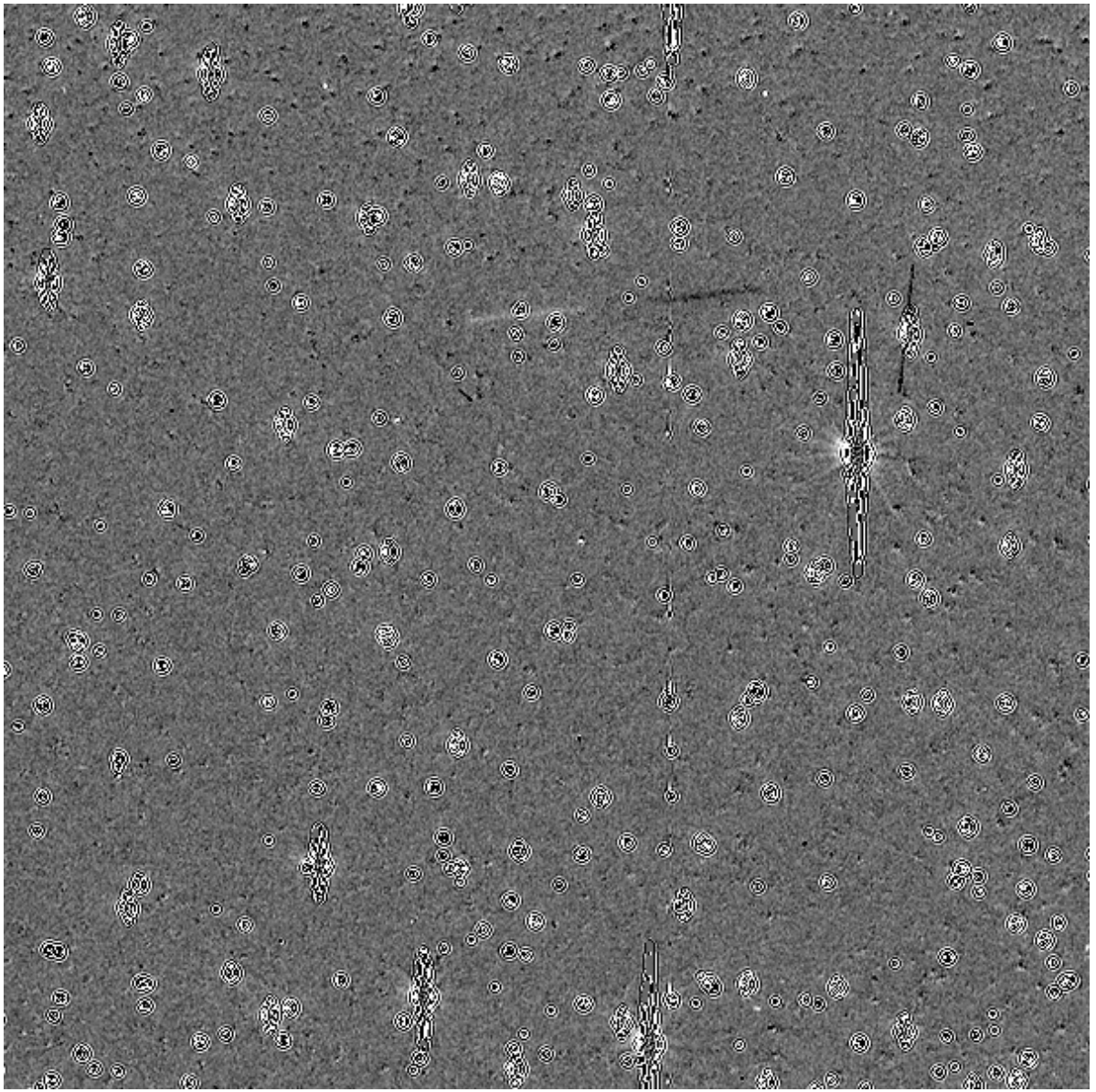
PSF Matching Example (Buie)

- Raw frame (dense star cloud)



PSF Matching Example (Buie)

- Two frames, same night, registered and PSF-matched
- Recover photon noise over most of frame



Search Facilities

- Preliminary list

Telescope	Instrument	Aperture	X FOV, arcmin	Y FOV, arcmin	Mean FOV	Grasp	Number of FOVs to cover 2012 search area	Notes
Subaru	Suprime-Cam	8	30	24	27	46.1	10.5	Not available 2010/7 - 2011/3?
Subaru	Hyper-Suprime-Cam	8	80	80	80	409.6	1.2	First light late 2011?
Keck	LRIS	10	6	7.8	7	4.7	161.5	Red and blue simultaneously
Gemini N	GMOS	8	5.5	5.5	6	1.9	249.9	
Gemini S	GMOS	8	5.5	5.5	6	1.9	249.9	
Magellan, Baade	IMACS	6.5	27	27	27	30.8	10.4	
Magellan, Clay	LDSS-3	6.5	7	7	7	2.1	154.3	Multi-object spectrograph
Magellan, Clay	MegaCam	6.5	25	25	25	26.4	12.1	Available late 2009
LBT	Large Binocular Camera	11.8	23	23	23	73.7	14.3	
VLT	FORS	8.2	6.8	6.8	7	3.1	163.5	
CFHT	MegaCam	3.6	60	60	60	46.7	2.1	
WIYN	One Degree Imager	3.5	60	60	60	44.1	2.1	Late 2010? Tip/tilt on-chip seeing
Kitt Peak 4m	MOSAIC	4	35	35	35	19.6	6.2	Poorer seeing
CTIO 4m	MOSAIC	4	35	35	35	19.6	6.2	Seeing?
CTIO 4m	Dark Energy Camera	4.2	103	103	103	187.1	0.7	Seeing?