



# NEO Survey Summary: Minor Planet Center Perspective

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Timothy Spahr  
Director, Minor Planet Center  
Smithsonian Astrophysical Observatory  
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# History of NEO discovery

First NEO discovered is (433) Eros, found in 1889

(1862) Apollo discovered in 1932

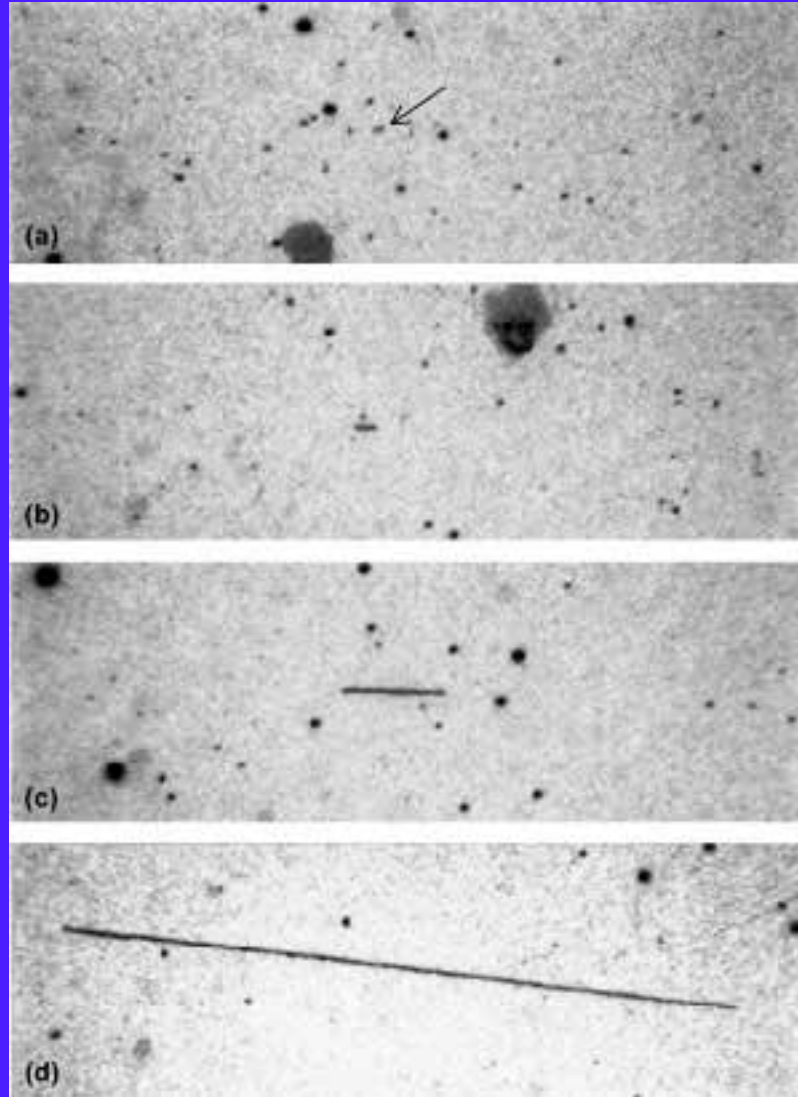
(2062) Aten found in 1976 (!)

Discoveries pre-1991 were made mostly on film or photographic plates (Palomar Sky Survey, supernova surveys (Baade, Mueller)

Pioneering work in true surveying done by Gehrels, Shoemaker & Shoemaker, and Helin in the 1970s-1980s.



# 1996JA<sub>1</sub> Discovery





# NEO Discovery Milestones

Spacewatch discovered first NEO on CCD in 1989,  
and first automatic NEO discovery 1990

NEAT (1996) first wide-field CCD NEO survey

LINEAR (1998) first nearly all-sky NEO survey

Catalina (2005) first routine use of “large” scope

WISE (2010) first large-scale IR survey and  
a real gamechanger for both discovery and science



# First Predicted Impact--2008 TC<sub>3</sub>

Discovered by Richard Kowalski at Catalina  
MLS survey (1.5m scope)

Discovered 19 hours before impact

MPC computers alerted staff to possible  
impact solutions

Chesley (JPL) & Williams (MPC) quickly  
computed impacting locale

Pieces recovered in desert by Jenniskens

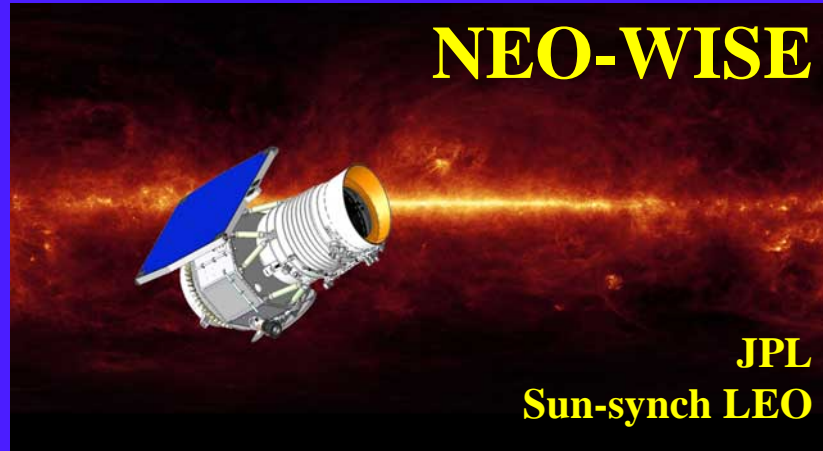


# NASA's NEO Observation Program (Current Systems)



## Minor Planet Center (MPC)

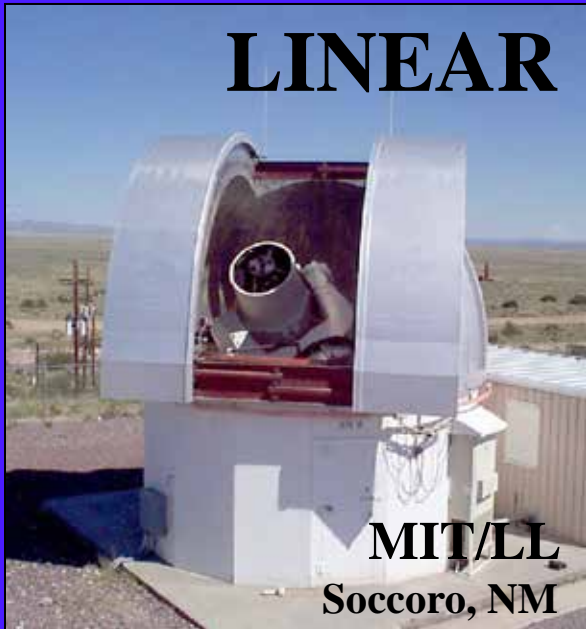
- IAU sanctioned
  - Int'l observation database
  - Initial orbit determination
- [www.cfa.harvard.edu/iau/mpc.html](http://www.cfa.harvard.edu/iau/mpc.html)
- ### NEO Program Office @ JPL
- Program coordination
  - Precision orbit determination
  - Automated SENTRY
- <http://neo.jpl.nasa.gov/>



## NEO-WISE

End of  
Operations  
Feb 2011,  
Analysis  
Of Data  
Continues

JPL  
Sun-synch LEO



## LINEAR

MIT/LL  
Socorro, NM



## Catalina Sky Survey

UofAZ  
Arizona & Australia

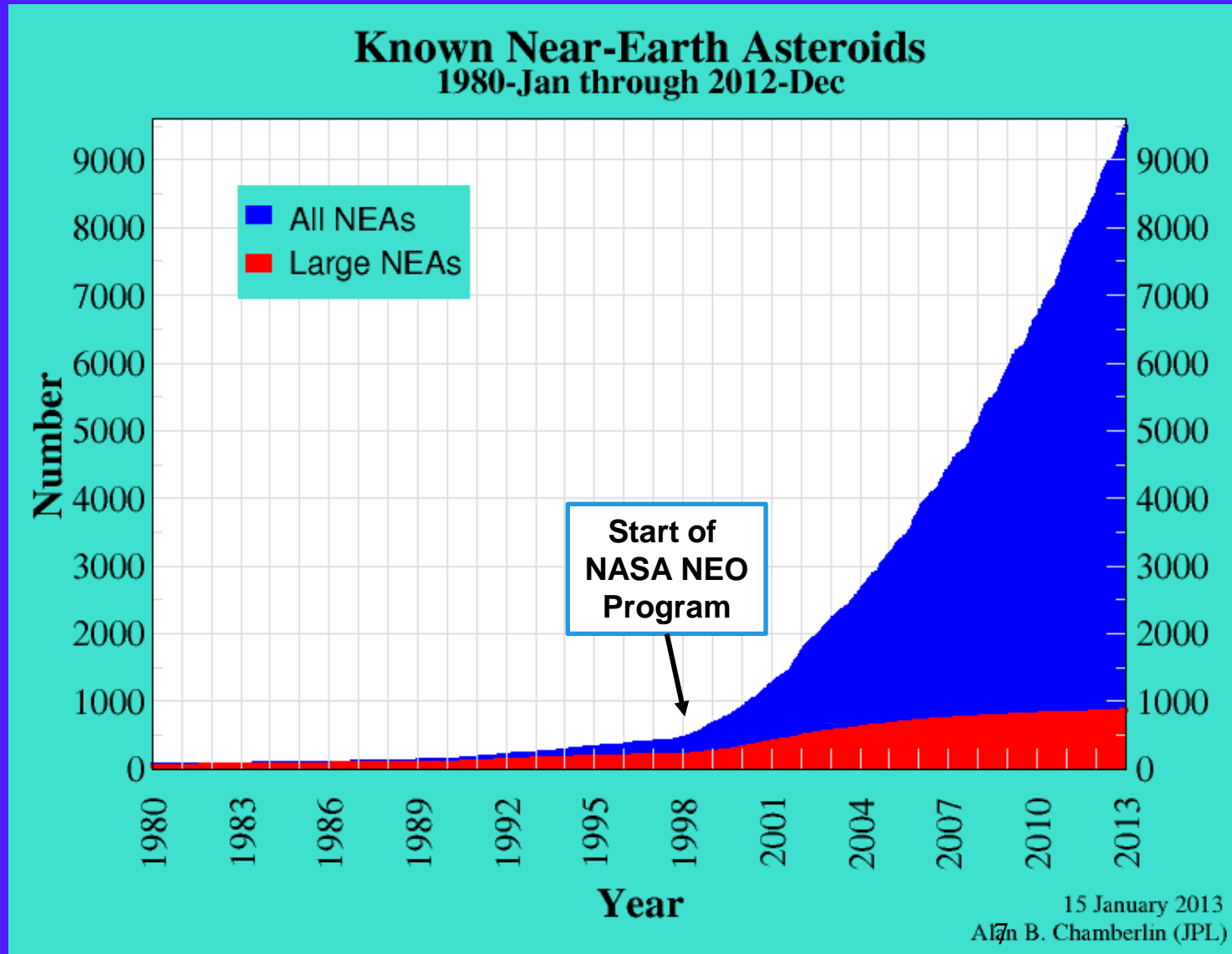


## Pan-STARRS

Uof HI  
Haleakula, Maui



# Known Near Earth Asteroid Population



9734  
4/4/13

860  
4/4/13



# NEOs: Current statistics (as of 9 April)



YEAR	NEO discoveries	“large” NEOs
TOTAL	9742	~860
2013	293	3
2012	994	18
2011	898	19
2010	916	15
2009	781	24





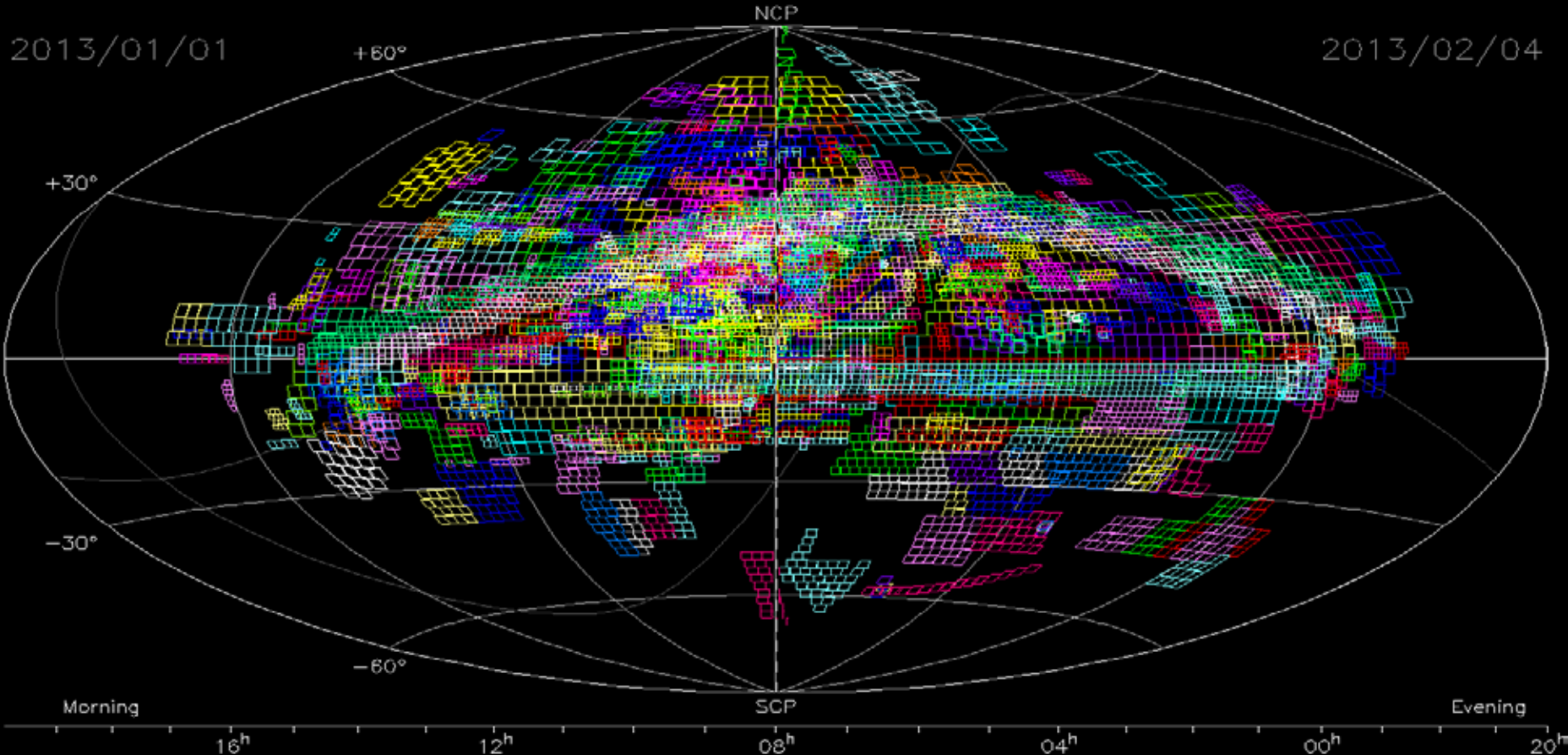
# Monthly Sky Coverage

## SKY COVERAGE

Plot prepared 2013/02/04.613 by the Minor Planet Center

2013/01/01

2013/02/04



Morning

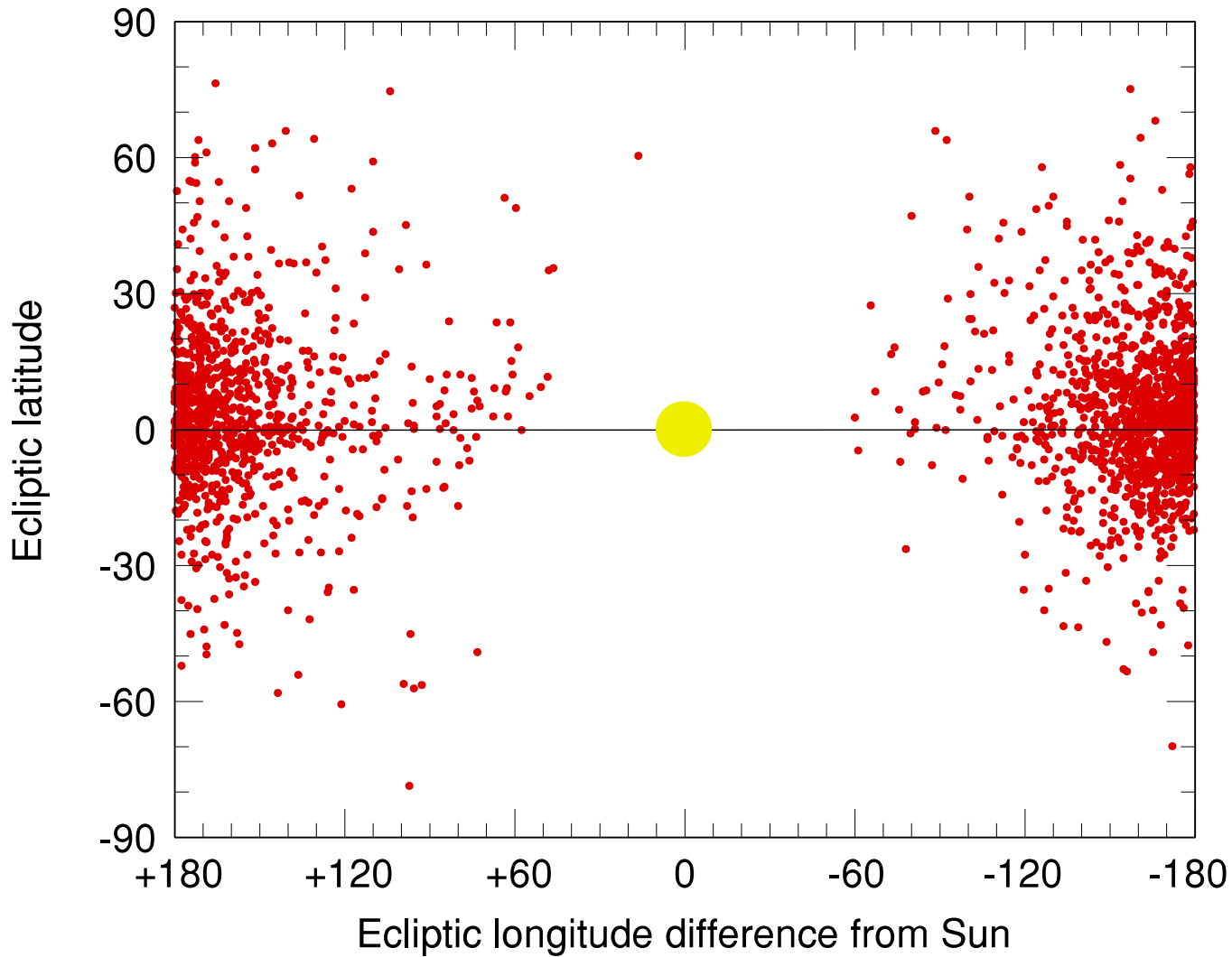
Evening

Opposition Point = 07 59.8,+20 35. Fields reaching fainter than  $V = 18.0$ .

- |   |  |  |   |  |
|---|--|--|---|--|
| <span style="color: red;">■</span> 2013/02/04 (2013 035)        | <span style="color: cyan;">■</span> 2013/02/03 (2013 034)      | <span style="color: blue;">■</span> 2013/02/02 (2013 033)    | <span style="color: yellow;">■</span> 2013/02/01 (2013 032)     | <span style="color: magenta;">■</span> 2013/01/31 (2013 031)   |
| <span style="color: orange;">■</span> 2013/01/30 (2013 030)     | <span style="color: lightblue;">■</span> 2013/01/29 (2013 029) | <span style="color: green;">■</span> 2013/01/28 (2013 028)   | <span style="color: lightcyan;">■</span> 2013/01/27 (2013 027)  | <span style="color: pink;">■</span> 2013/01/26 (2013 026)      |
| <span style="color: lightgreen;">■</span> 2013/01/25 (2013 025) | <span style="color: purple;">■</span> 2013/01/24 (2013 024)    | <span style="color: magenta;">■</span> 2013/01/23 (2013 023) | <span style="color: cyan;">■</span> 2013/01/22 (2013 022)       | <span style="color: lightblue;">■</span> 2013/01/21 (2013 021) |
| <span style="color: yellow;">■</span> 2013/01/20 (2013 020)     | <span style="color: red;">■</span> 2013/01/19 (2013 019)       | <span style="color: green;">■</span> 2013/01/18 (2013 018)   | <span style="color: blue;">■</span> 2013/01/17 (2013 017)       | <span style="color: yellow;">■</span> 2013/01/16 (2013 016)    |
| <span style="color: magenta;">■</span> 2013/01/15 (2013 015)    | <span style="color: orange;">■</span> 2013/01/14 (2013 014)    | <span style="color: cyan;">■</span> 2013/01/13 (2013 013)    | <span style="color: lightgreen;">■</span> 2013/01/12 (2013 012) | <span style="color: lightblue;">■</span> 2013/01/11 (2013 011) |
| <span style="color: white;">■</span> 2013/01/10 (2013 010)      | <span style="color: cyan;">■</span> 2013/01/09 (2013 009)      | <span style="color: red;">■</span> 2013/01/08 (2013 008)     | <span style="color: green;">■</span> 2013/01/07 (2013 007)      | <span style="color: lightcyan;">■</span> 2013/01/06 (2013 006) |

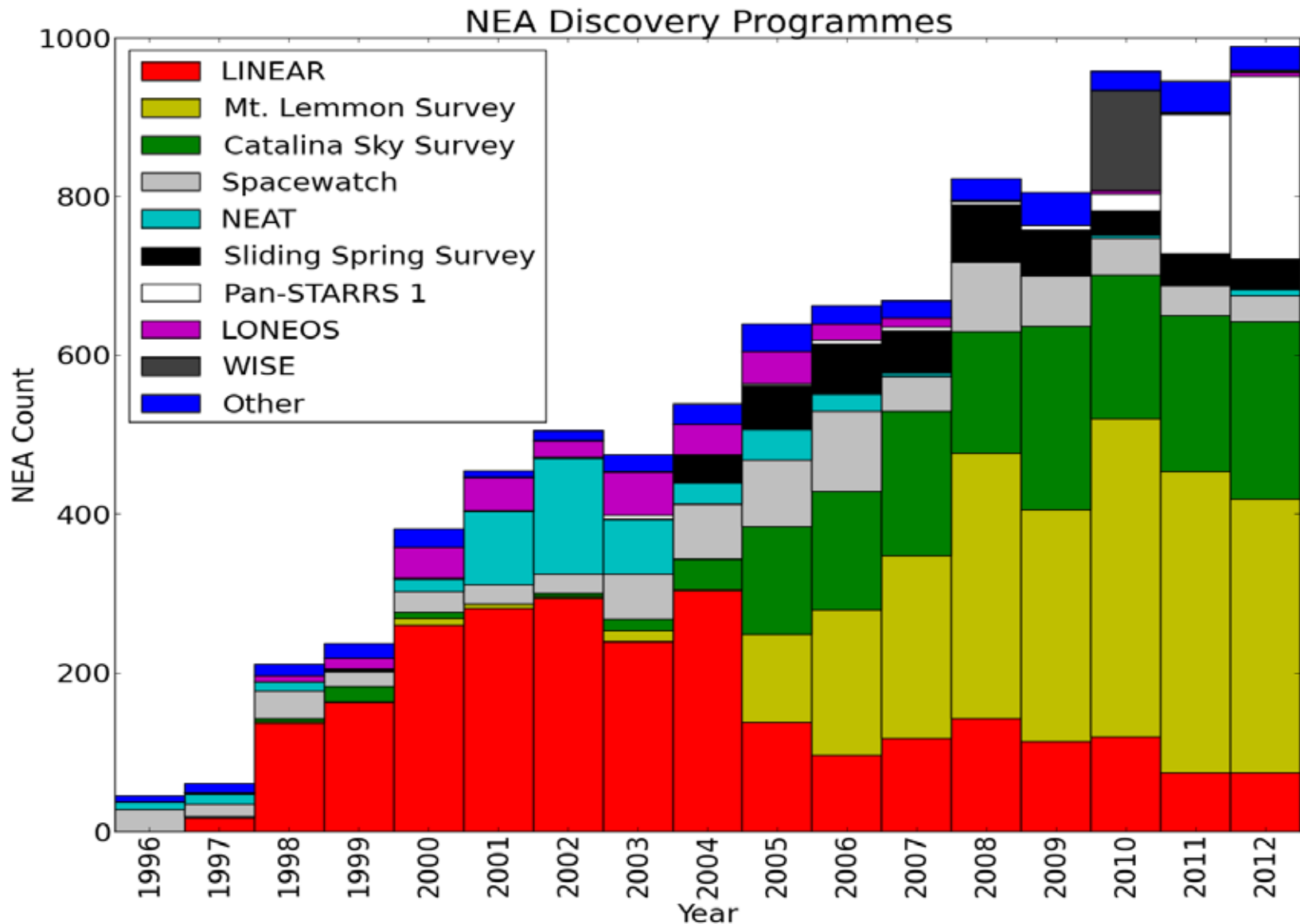


# Ecliptic Latitude & Elongation



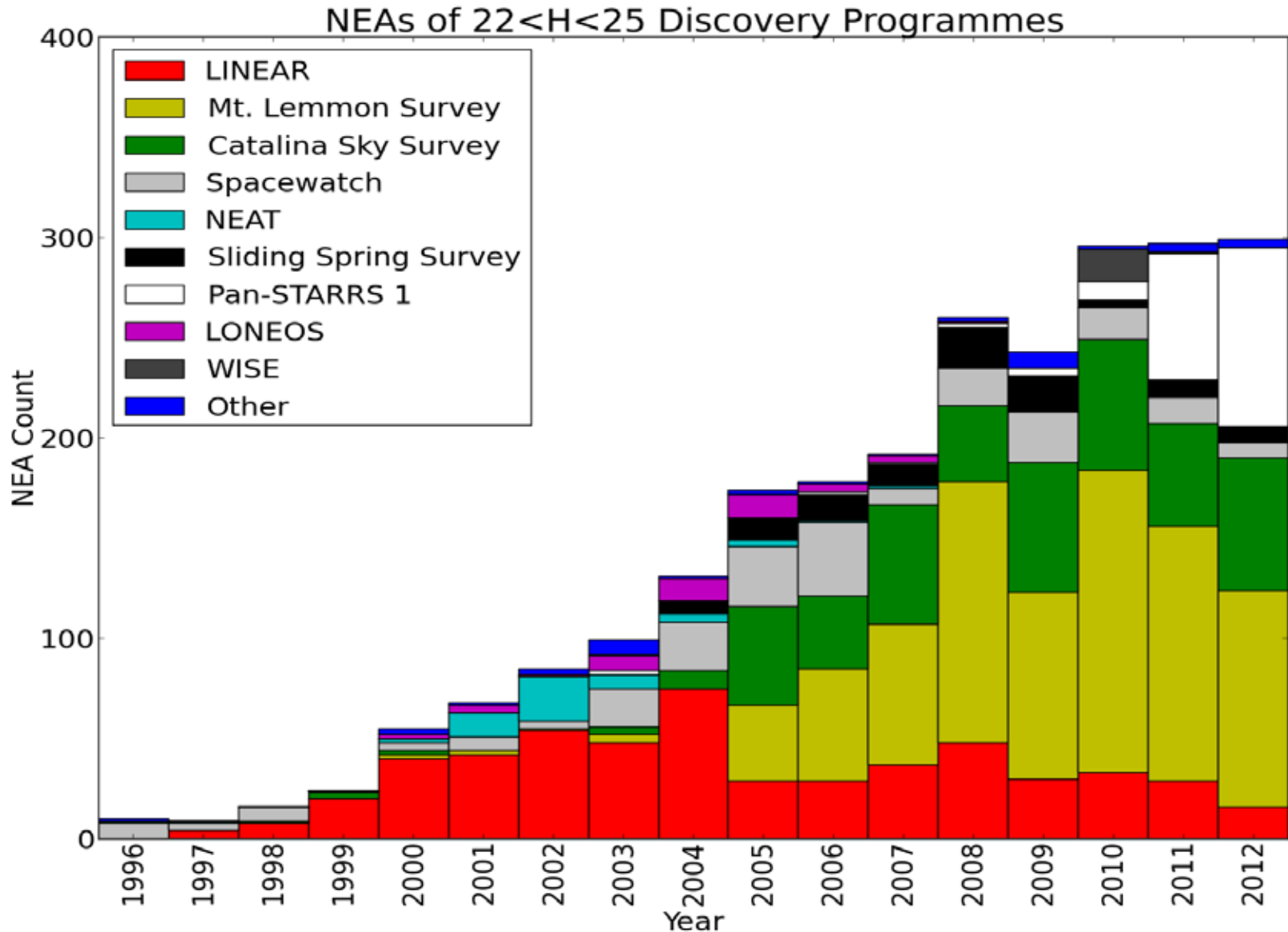


# All NEO Discoveries





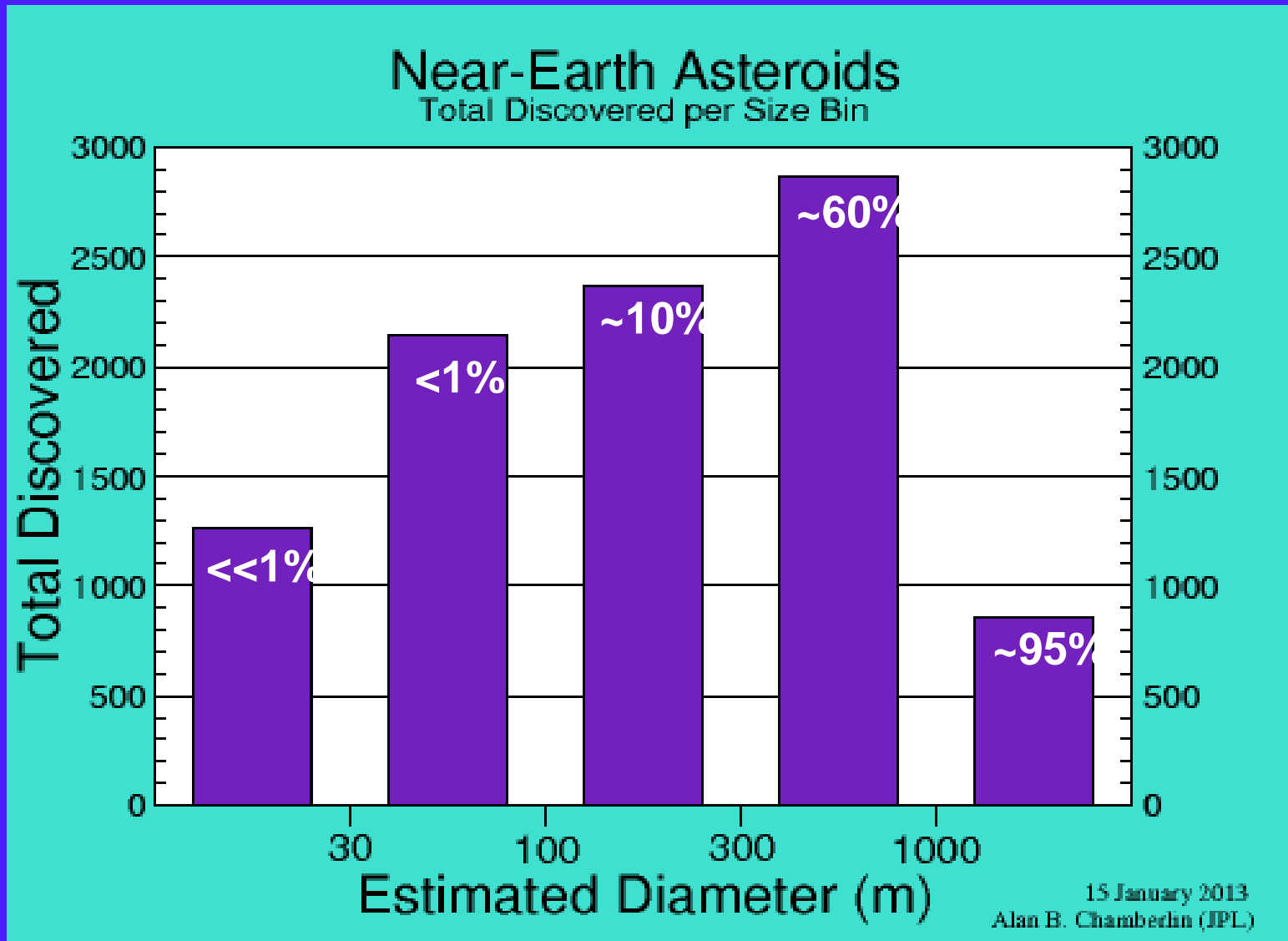
# NEO Discoveries 30-150m diameter







# Known Near Earth Asteroid Population

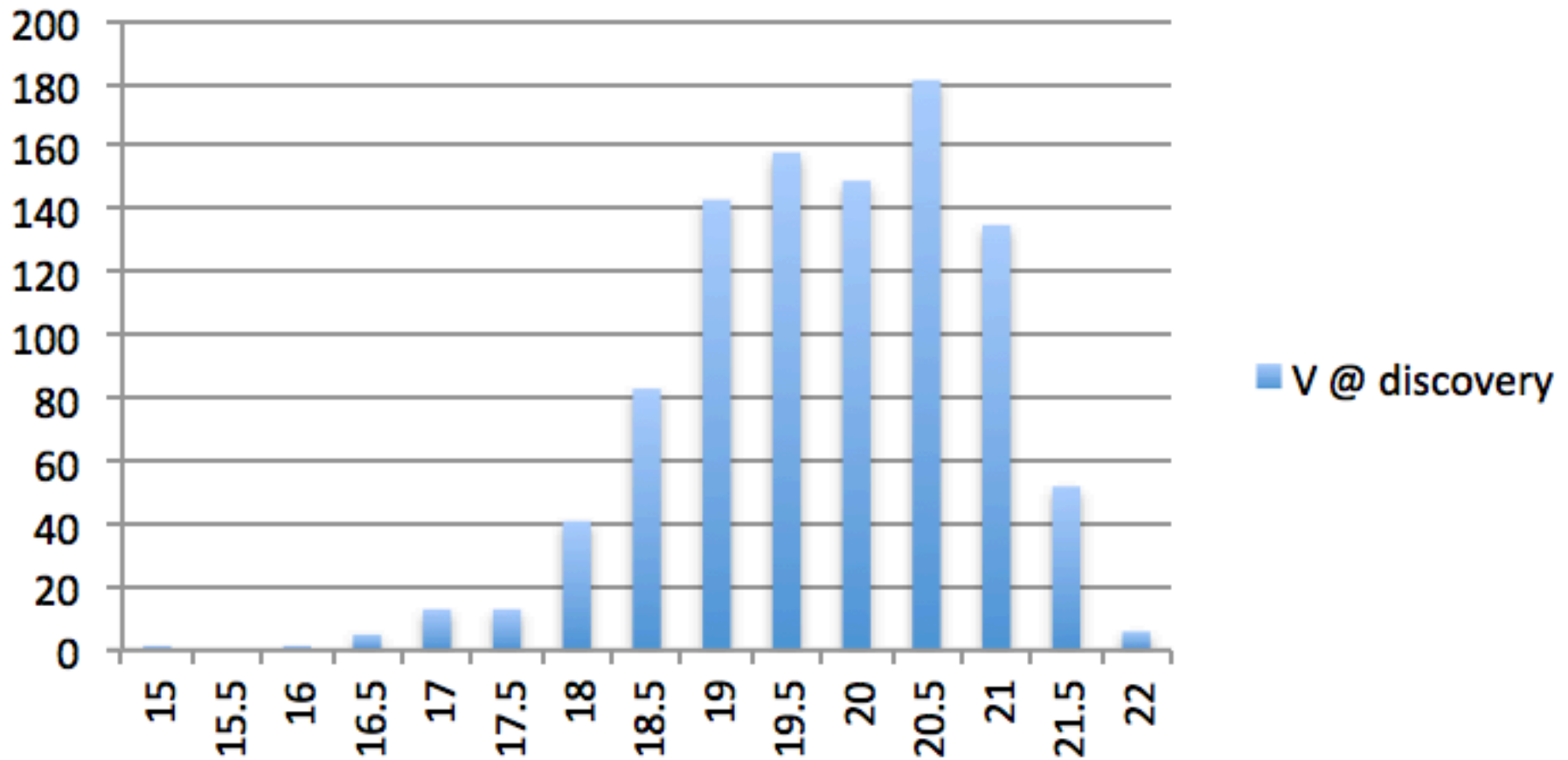


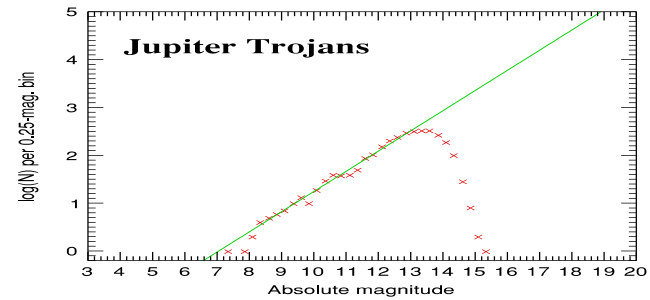
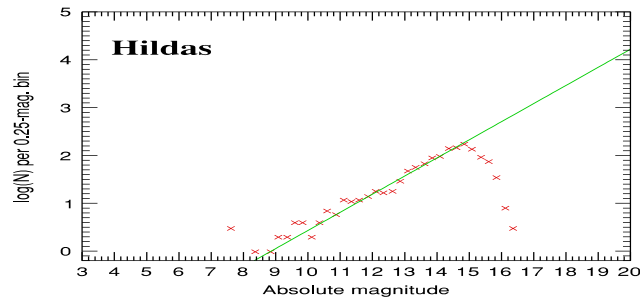
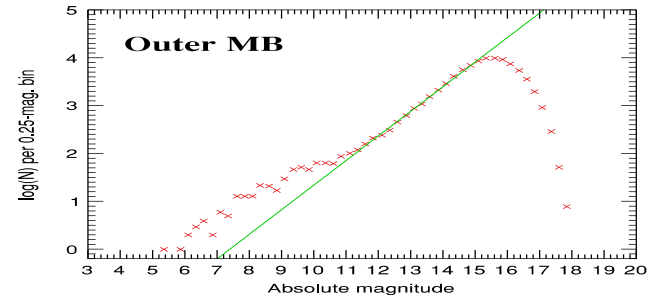
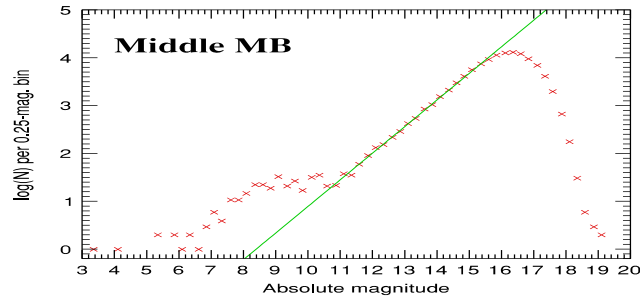
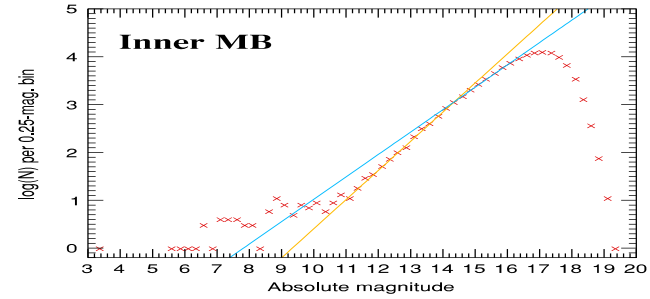
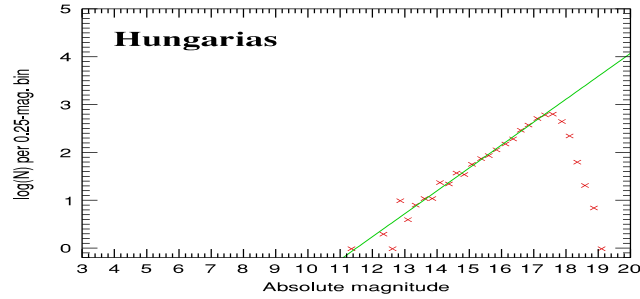
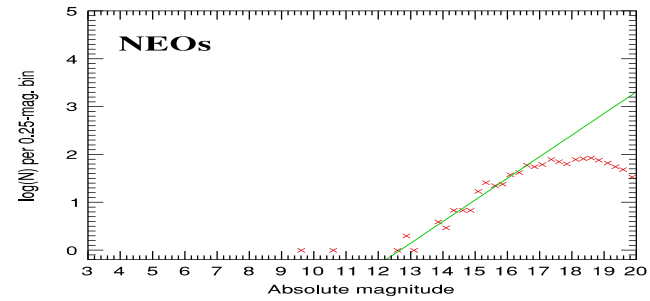
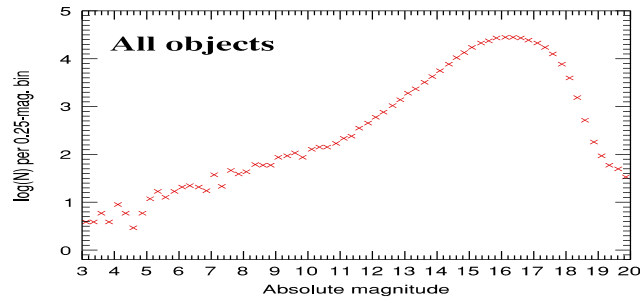


# Discovery Magnitudes



## V @ discovery





G. V. Williams  
dissertation  
research





## Notes on coordination

- Some duplication in current survey patterns
- Simple communication has been happening among observers for years (hey don't shoot there tonight, try tomorrow instead!)
- Some modeling of using the existing resources to maximize throughput
- Mixing astrometric sets from different surveys strengthens orbital solutions
- Build solid main belt asteroid catalog!



# Conclusions

- Existing groundbased efforts continue to succeed
- Contributions from larger telescopes becoming more important
- Approaching completeness in NEO population to a few km in size, to ~5 km in main belt
- NEOWISE science and discovery results a gamechanger
- Communication & modeling improve cooperation