Defending Planet Earth From Cosmic Collisions

Irwin Shapiro

Rayburn House Office Building 2325

8 July 2013

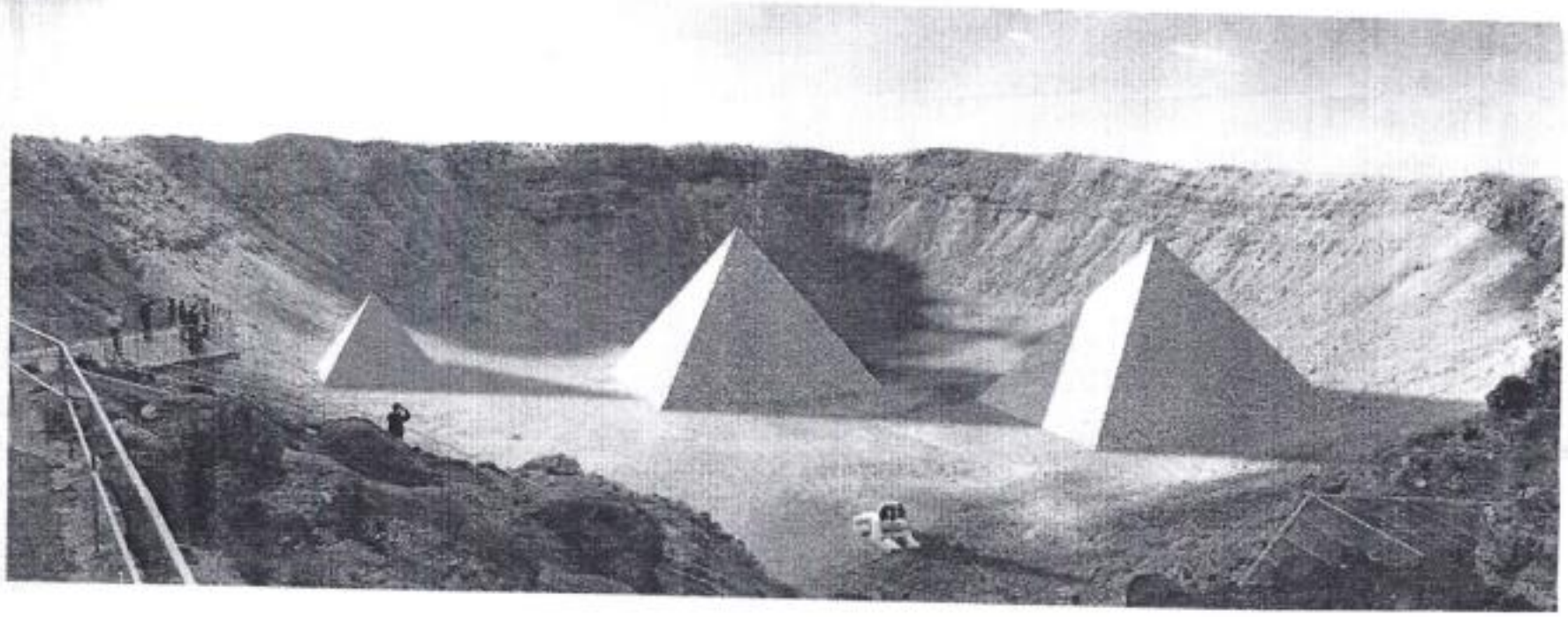
Scene Setting

Human understanding of cosmic objects striking Earth: Ernst Chladni (1790s); Jefferson story

Asteroid/comet effects on Earth (small sample):

Meteor Crater in Arizona (next slide)

Part of Chelyabinsk meteorite (next slide + 1)



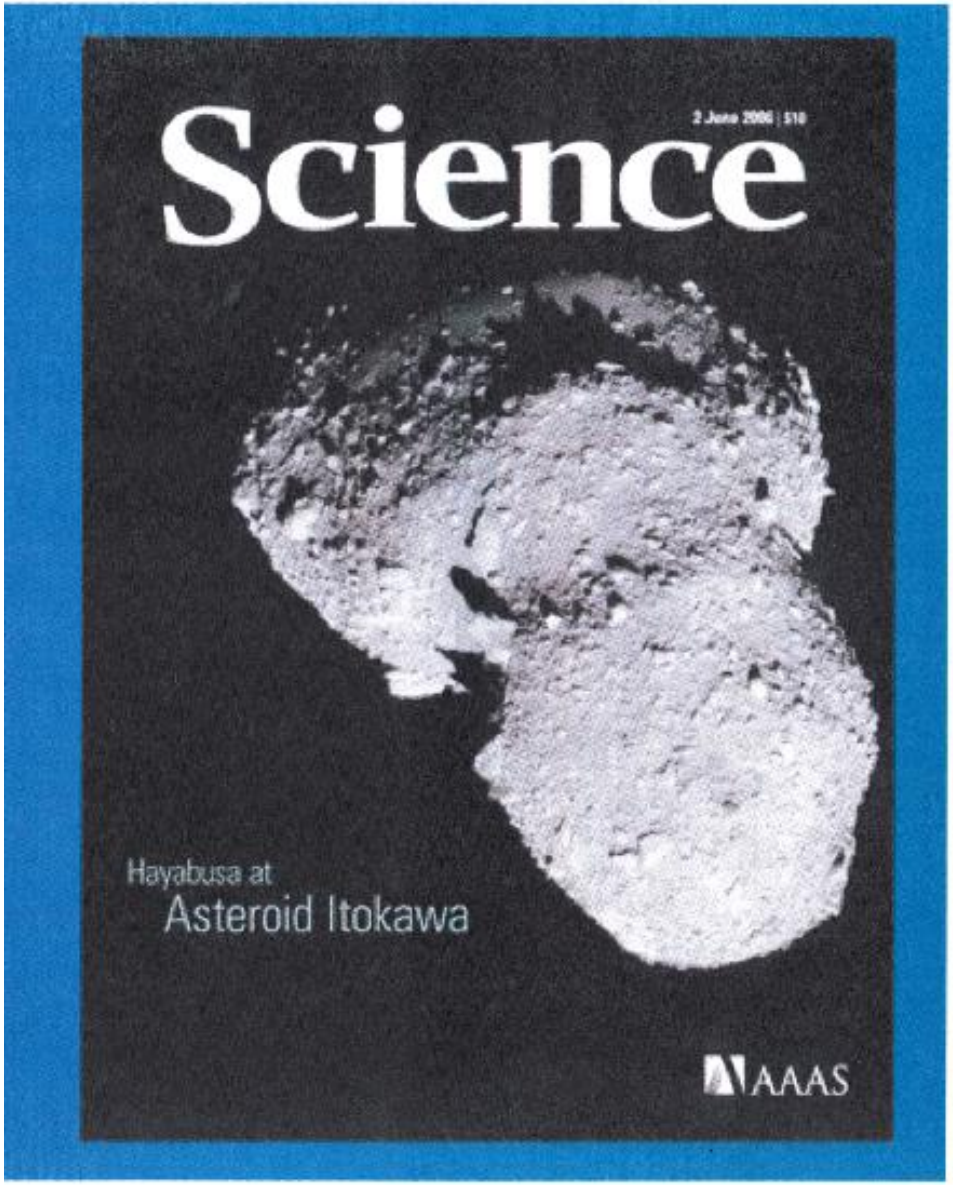
Crater From Chelyabinsk Fragment

Threat And Response

What do we know now? See next three slides.

What is the threat vs. size of collider? See next slide plus three.

What can we do about it? See next slide plus four.


Science
2 June 2006 | $10
Hayabusa at
Asteroid Itokawa
AAAS

Approximate Numbers Of Objects

How many asteroids and comets have so far been discovered and tracked? >600,000

How many are near earth objects ("NEOs")? (By somewhat arbitrary definition: NEO has orbit passing within ~45 million kilometers of Earth's.) ~10,000

What percent, as function of size, has been discovered? E.g., 90% (~1,000 objects) > I km in size; 20% (~6,000 objects) > 0.14 km in size

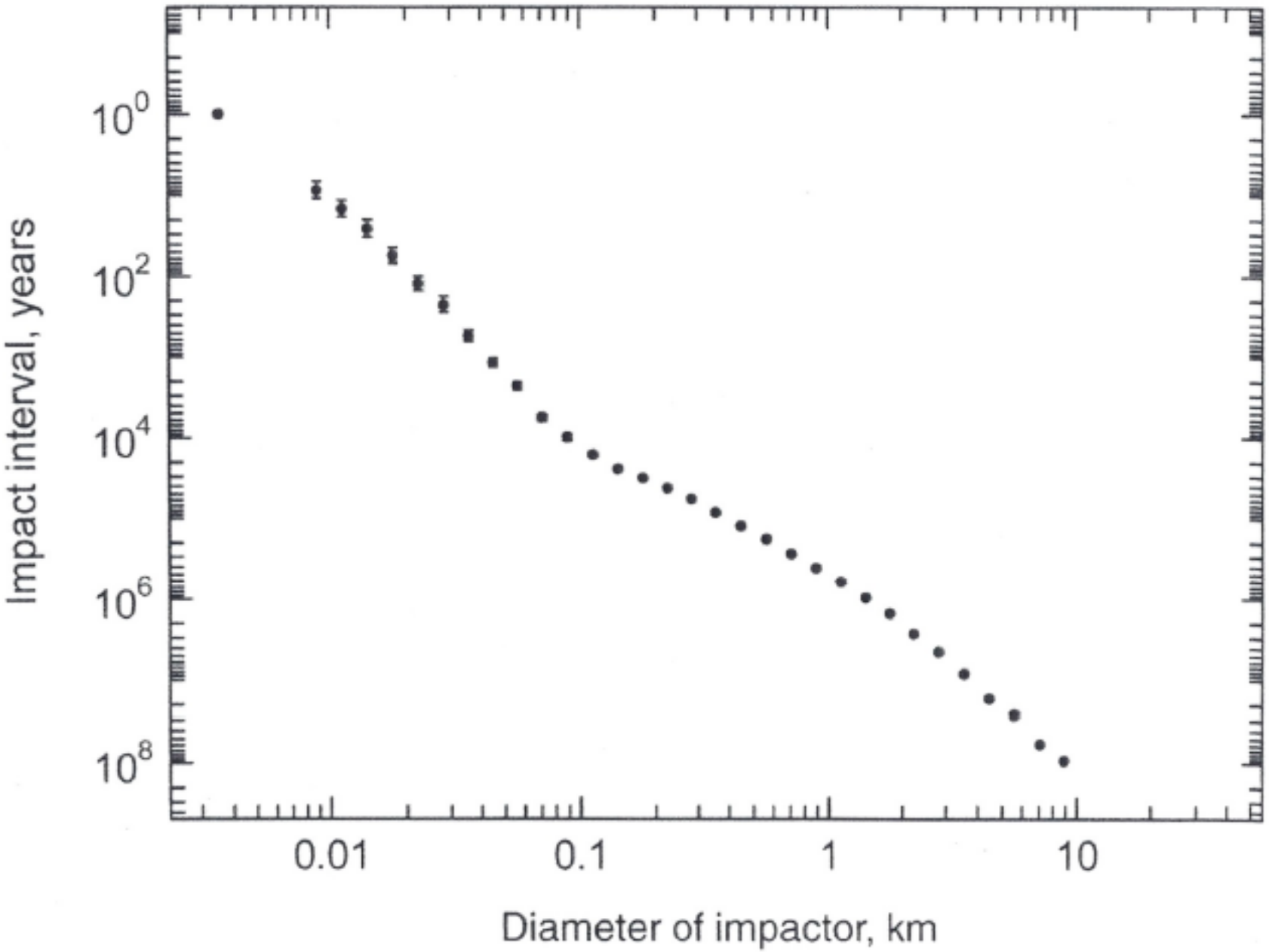
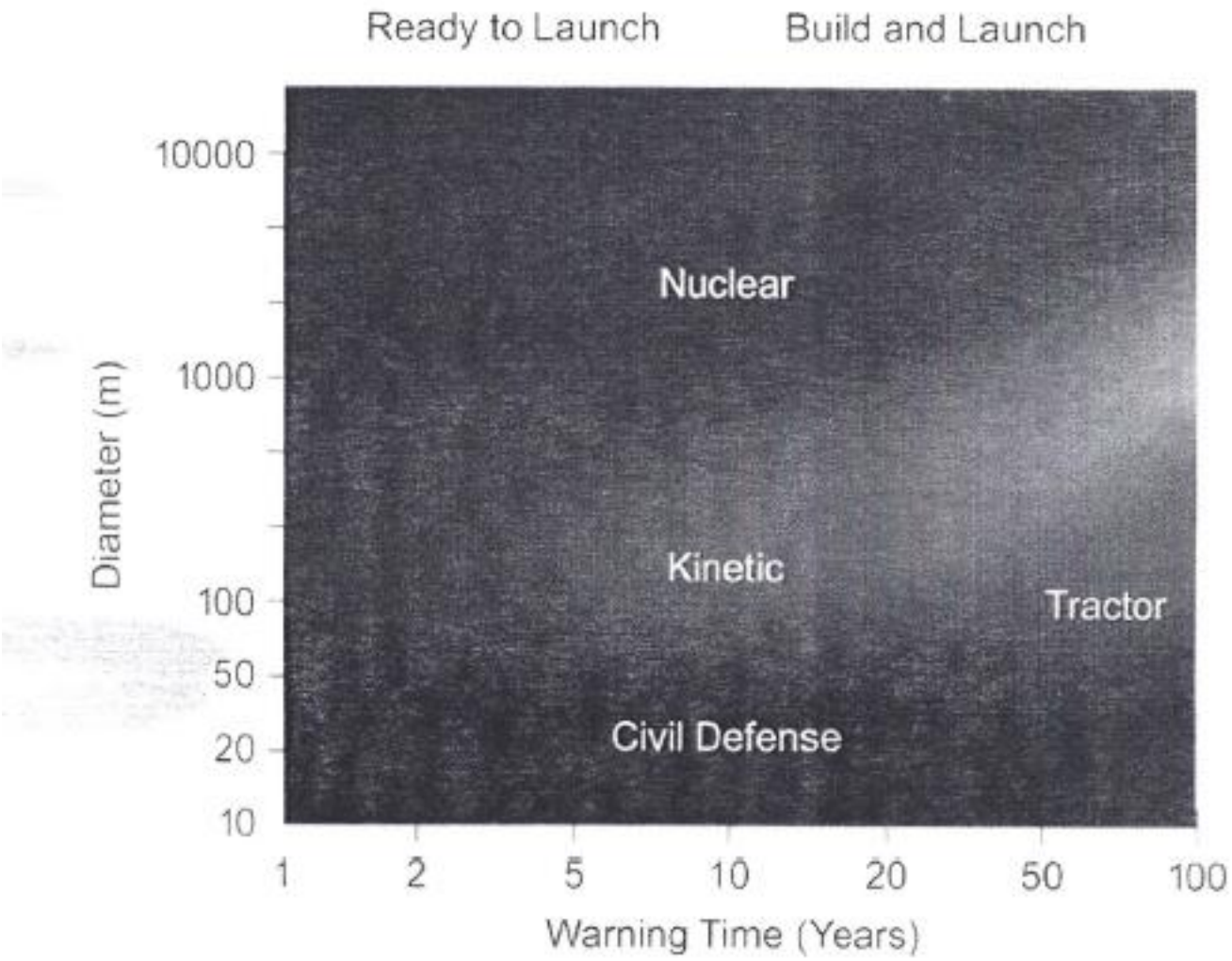

Impact interval, years
10^0
10^2
10^4
10^6
10^8
0.01
0.1
1
10
Diameter of impactor, km

TABLE 2.1 Approximate Average Impact Interval and Impact Energy for Near-Earth Objects

Type of Event	Characteristic Diameter of Impacting Object	Approximate Impact Energy (MT)	Approximate Average Impact Interval (yrs)
Airburst	25 m	1	200
Local scale	50 m	10	2,000
Regional scale	140 m	300	30,000
Continental scale	300 m	2,000	100,000
Below global catastrophe threshold	600 m	20,000	200,000
Possible global catastrophe	1 km	100,000	700,000
Above global catastrophe threshold	5 km	10 million	30 million
Mass extinction	10 km	100 million	100 million


Ready to Launch
Build and Launch
10000
1000
100
50
20
10
Diameter (m)
Nuclear
Kinetic
Tractor
Civil Defense
1
2
5
10
20
50
100
Warning Time (Years)

What More Should Be Done Now?

First, look better, from ground and from space, to see what might be coming:

Ground (add; see below): LSST, FlyEye, …

Space: NEOSSat, AsteroidFinder, Sentinel,…

Retain (e.g.): Catalina Survey; PanSTARRS; and radar (Arecibo and Goldstone)

Unique Opportunity

As opposed to other natural calamities (earthquakes, hurricanes, tornados, tsunamis), we can prevent cosmic collisions in many cases and accurately predict in all. Worth the insurance policy cost?

We are not like the dinosaurs (see last slide).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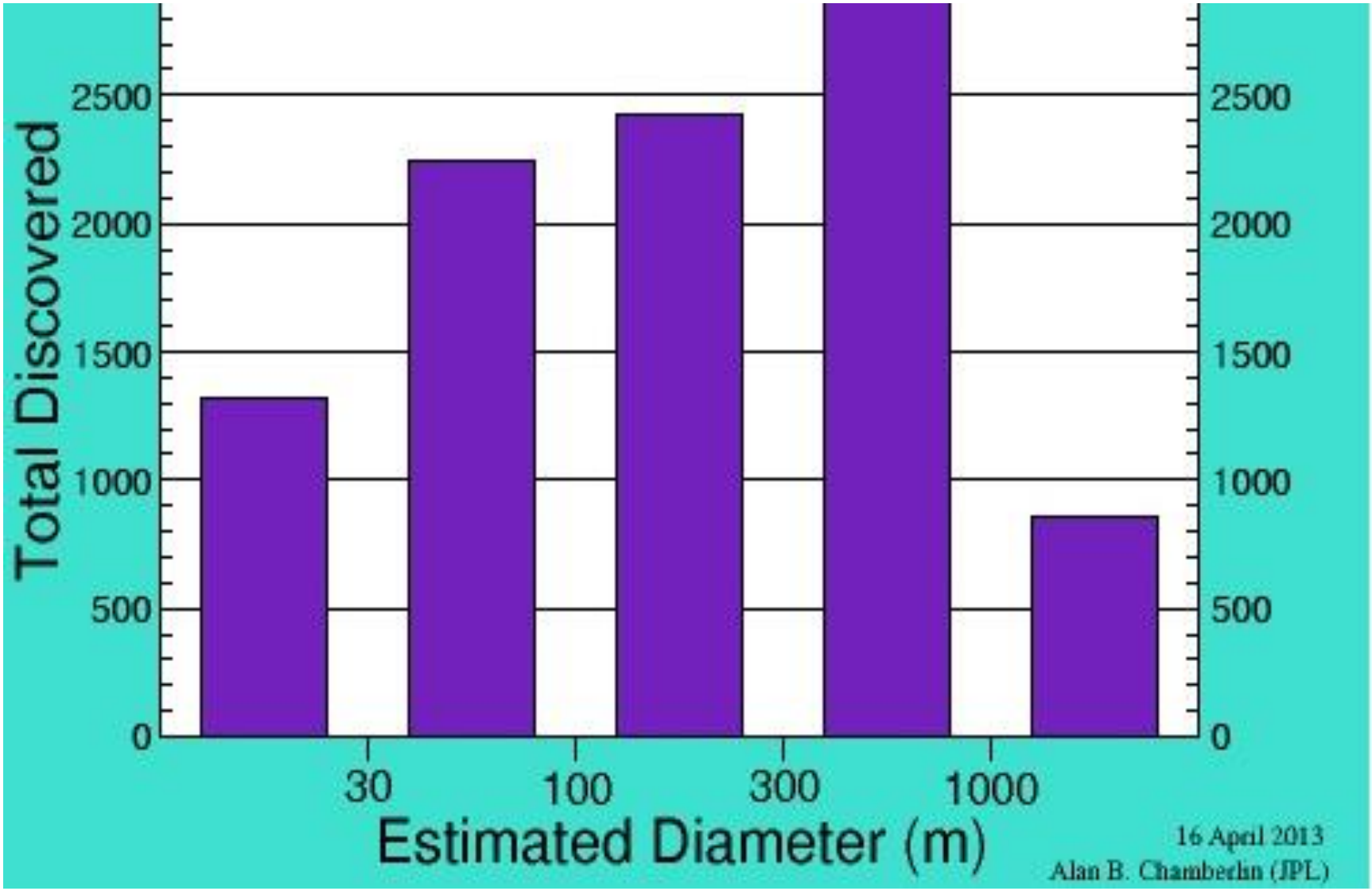
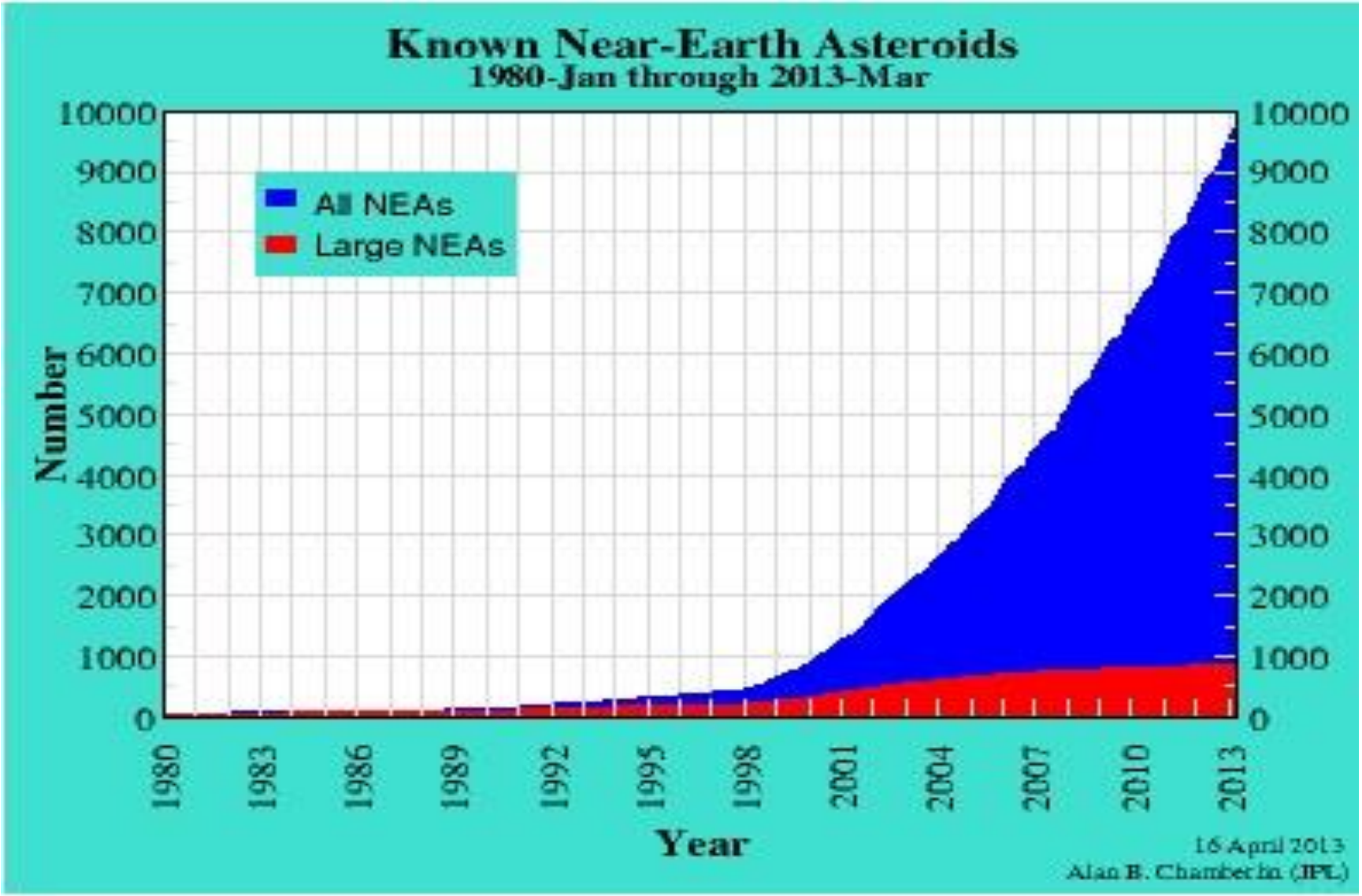
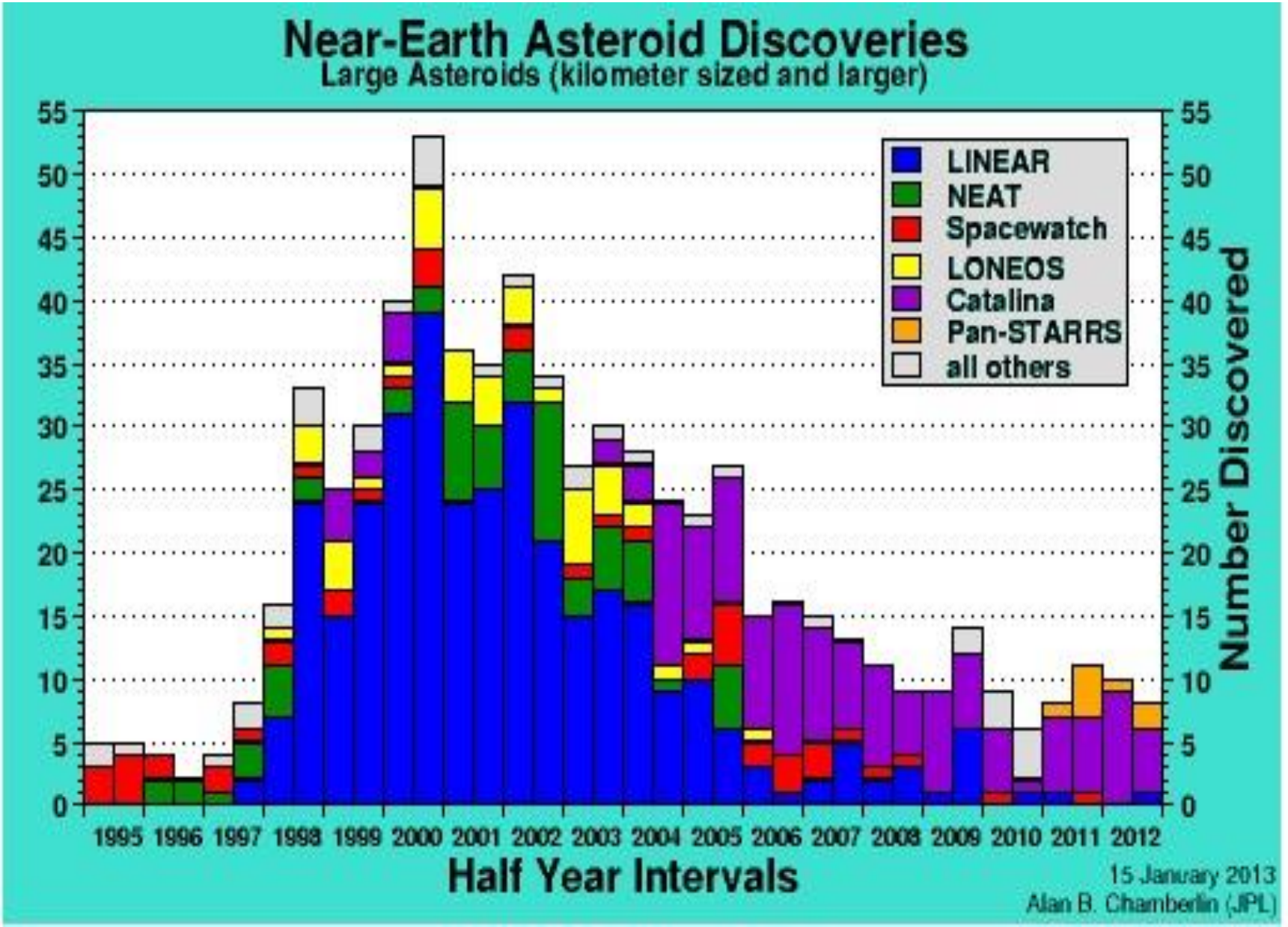
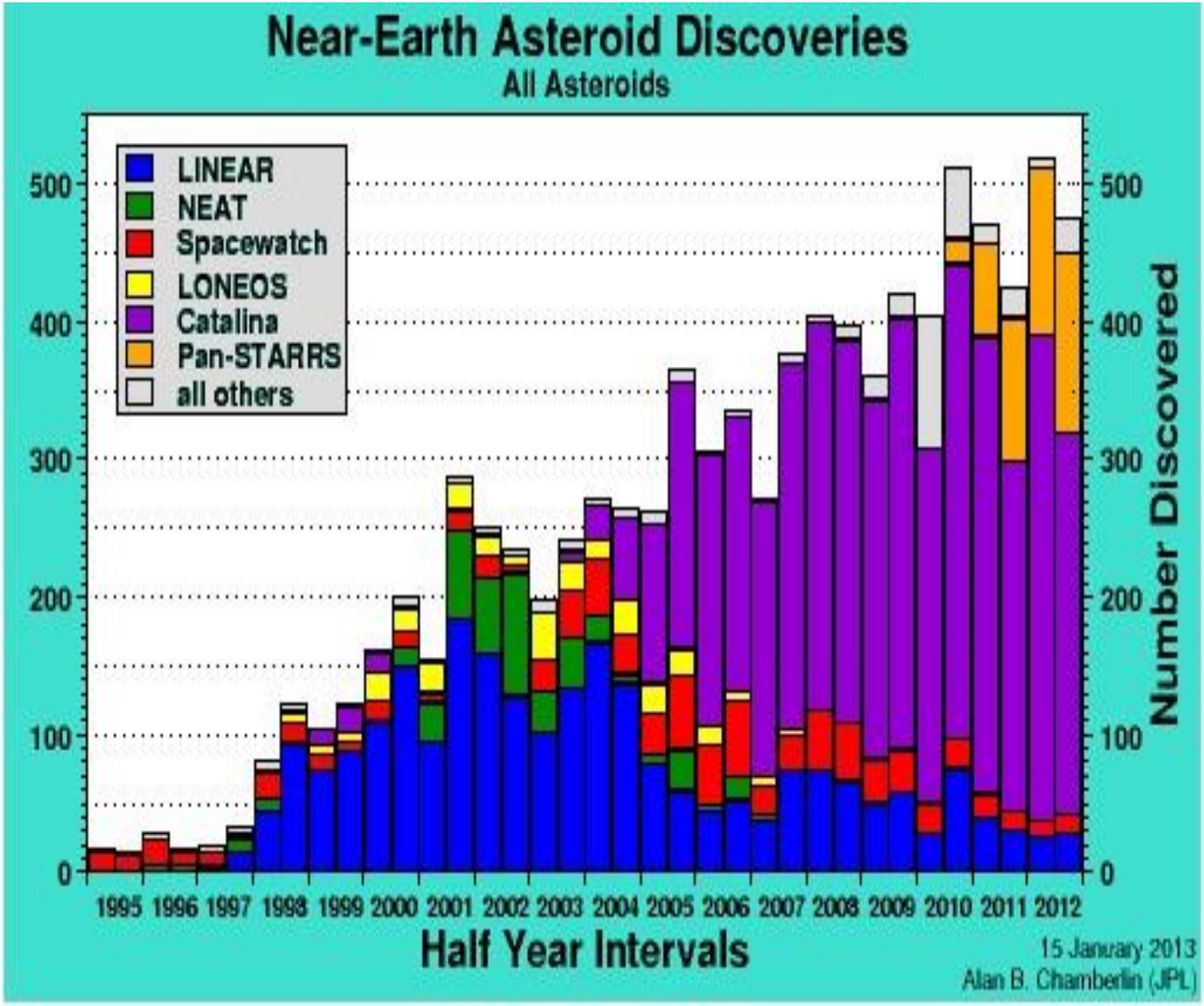
Known NEOs Vs. Size



Discoveries of NEAs Versus Time (Comets, ~ 1% of Total, Omitted)




Near-Earth Asteroid Discoveries
Large Asteroids (kilometer sized and larger)
LINEAR
NEAT
Spacewatch
LONEOS
Catalina
Pan-STARRS
all others
Number Discovered
0
5
10
15
20
25
30
35
40
45
50
55
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Half Year Intervals
15 January 2013
Alan B. Chamberlin (JPL)


Near-Earth Asteroid Discoveries
All Asteroids
LINEAR
NEAT
Spacewatch
LONEOS
Catalina
Pan-STARRS
all others
0
100
200
300
400
500
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Half Year Intervals
Number Discovered
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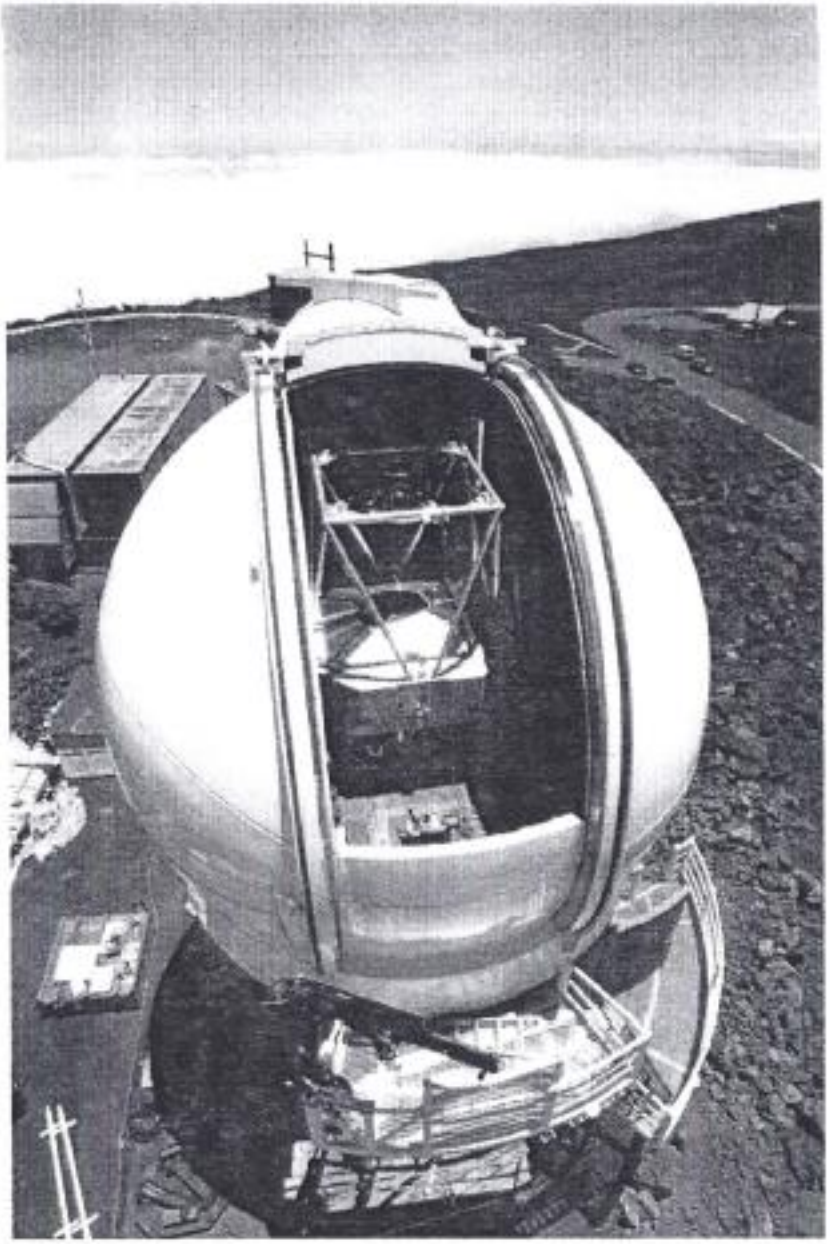

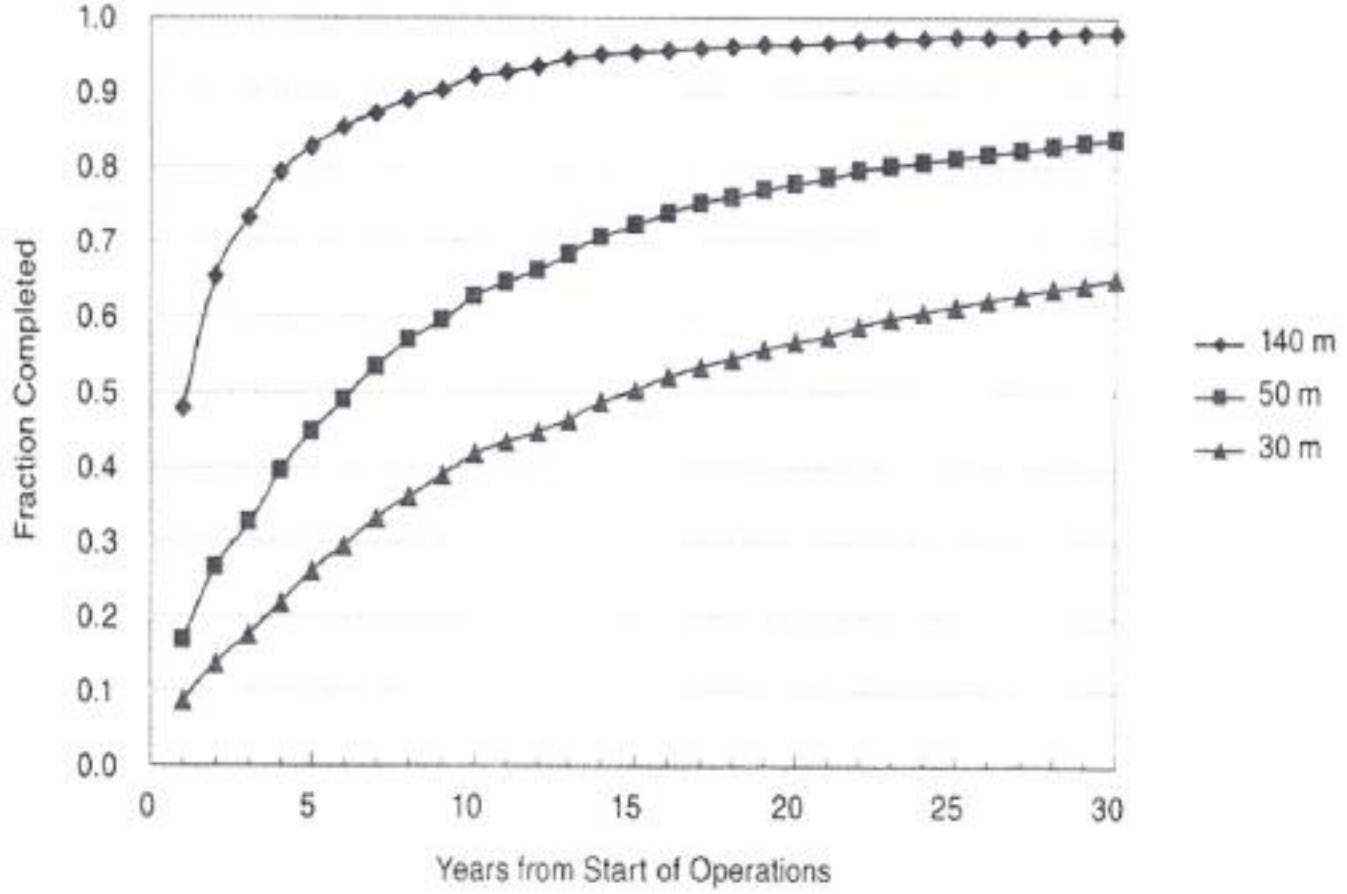
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Fraction Completed
0
5
10
15
20
25
30
Years from Start of Operations
140 m
50 m
30 m