Asteroids: What, where, how and why we care?

Dr. Harold Geller
George Mason University
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What is an Asteroid?
## Asteroid Sizes

<table>
<thead>
<tr>
<th>Asteroid</th>
<th>Size (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceres</td>
<td>940</td>
</tr>
<tr>
<td>Vesta</td>
<td>549</td>
</tr>
<tr>
<td>Eros</td>
<td>23</td>
</tr>
<tr>
<td>Apollo</td>
<td>1.4</td>
</tr>
<tr>
<td>Ida</td>
<td>58 x 23</td>
</tr>
<tr>
<td>Gaspra</td>
<td>17 x 10</td>
</tr>
<tr>
<td>Kleopatra</td>
<td>217 x 94</td>
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</table>
Where are they?

&

Where do they come from?
How do we study asteroids?
LINEAR NEO Search Systems
# Asteroids: Years of Discovery

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Year</th>
<th>Size km</th>
<th>Orbit AU</th>
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<tbody>
<tr>
<td>2062</td>
<td>Aten</td>
<td>1976</td>
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<tr>
<td>433</td>
<td>Eros</td>
<td>1898</td>
<td>23</td>
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<td>1862</td>
<td>Apollo</td>
<td>1932</td>
<td>1.4</td>
<td>1.47</td>
</tr>
<tr>
<td>1221</td>
<td>Amor</td>
<td>1932</td>
<td>1.0</td>
<td>1.92</td>
</tr>
<tr>
<td>4</td>
<td>Vesta</td>
<td>1807</td>
<td>549</td>
<td>2.36</td>
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<td>1847</td>
<td>210</td>
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<td>44</td>
<td>Nysa</td>
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<td>73</td>
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<td>6</td>
<td>Hebe</td>
<td>1847</td>
<td>201</td>
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<td>21</td>
<td>Lutetia</td>
<td>1852</td>
<td>115</td>
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<tr>
<td>19</td>
<td>Fortuna</td>
<td>1852</td>
<td>215</td>
<td>2.44</td>
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<td>3</td>
<td>Juno</td>
<td>1804</td>
<td>265</td>
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<tr>
<td>1</td>
<td>Ceres</td>
<td>1801</td>
<td>940</td>
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<tr>
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<td>Pallas</td>
<td>1802</td>
<td>540</td>
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<td>Psyche</td>
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<td>265</td>
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<td>10</td>
<td>Hygeia</td>
<td>1849</td>
<td>410</td>
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<td>Hildago</td>
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NEAR Shoemaker
EROS Asteroid 433
NEAR Shoemaker Final Descent from 35-km Orbit

Eros South Pole

View from Sun
Hayabusa Visiting Asteroid Itokawa
Hayabusa Visiting Asteroid Itokawa
Why do we care?
What happens if an Asteroid hits the Earth?
Meteor Crater, Arizona
Civilization Threatening Impact

Mass Extinction Impact

Earth Sterilizing Impact
What Happens When an Impact Takes Place?

Bolides (up to 5 MT)
- Great fireworks display, no damage

Tunguska-class (15 MT) impact
- Damage similar to large nuclear bomb (city-killer)
- Average interval for whole Earth: 100 yr.
- Minor risk relative to other natural disasters (earthquakes, etc.)

Larger local or regional catastrophes (e.g. 10,000 MT)
- Destroys area equivalent to small country
- Average interval for whole Earth: 100,000 yr.
- Moderate risk relative to other natural disasters

Global catastrophe (> 1 million MT)
- Global environmental damage, threatening civilization
- Average interval for whole Earth: 1 million years
- Major risk relative to other natural disasters
Could it happen to us?
Terrestrial Impact Frequency

- Year
- Century
- Ten thousand yr.
- Million yr.
- Billion yr.

TNT equivalent yield (MT)

- Hiroshima
- Tunguska
- Tsunami danger
- Global catastrophe
- K/T
What Can We Do?
Strategies

- Detect
  Project NEO (Near Earth Objects)
  http://neo.jpl.nasa.gov/
- Deflect
  Gravitational Tractor Impactor
- Destroy
LINEAR NEO Search Systems
Civilization Threatening Impact
Mass Extinction Impact
Earth Sterilizing Impact
Known Kilometer-Size Near Earth Asteroids

estimated total NEAs > 1 km

1000
500

1990 1995 2000

Spaceguard official start
Final images of asteroid Eros acquired by NEAR Shoemaker on February 12, 2001. *(Upper Left)* Taken from 3,773 feet (1.2 kilometers) away. *(Upper Right)* Taken from 2,300 feet (700 meters) away. *(Bottom Left)* Taken from 820 feet (250 meters) away. *(Bottom Right)* The last image of Eros, taken from 420 feet (130 meters) away.
Looks like a potato?
Earth passes through trail of comet particles
2001 Leonid Meteor Shower

preliminary meteor rates from the
International Meteor Organization

meteors per hour (ZHR)

universal time
Questions??