Defending Planet Earth From Cosmic Collisions

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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.
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) > 1 km in size; 20% (~6,000 objects) > 0.14 km in size
<table>
<thead>
<tr>
<th>Type of Event</th>
<th>Characteristic Diameter of Impacting Object</th>
<th>Approximate Impact Energy (MT)</th>
<th>Approximate Average Impact Interval (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airburst</td>
<td>25 m</td>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>Local scale</td>
<td>50 m</td>
<td>10</td>
<td>2,000</td>
</tr>
<tr>
<td>Regional scale</td>
<td>140 m</td>
<td>300</td>
<td>30,000</td>
</tr>
<tr>
<td>Continental scale</td>
<td>300 m</td>
<td>2,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Below global catastrophe threshold</td>
<td>600 m</td>
<td>20,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Possible global catastrophe</td>
<td>1 km</td>
<td>100,000</td>
<td>700,000</td>
</tr>
<tr>
<td>Above global catastrophe threshold</td>
<td>5 km</td>
<td>10 million</td>
<td>30 million</td>
</tr>
<tr>
<td>Mass extinction</td>
<td>10 km</td>
<td>100 million</td>
<td>100 million</td>
</tr>
</tbody>
</table>
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).
RELAX. WE'RE TOO BIG TO FAIL.
Known NEOs Vs. Size

[Bar chart showing the total number of discovered NEOs by estimated diameter in meters.]

16 April 2013
Alan B. Chamberlin (JPL)
Discoveries of NEAs Versus Time (Comets, ~ 1% of Total, Omitted)