19. Near-Earth Objects
Chelyabinsk Meteor: 2013

~0.5 megaton airburst

~1500 people injured
Great Daylight Fireball: 1972
Tunguska Meteor: 1908

Asteroid or comet: $D \sim 40 \text{ m}$

$\sim 10$ megaton airburst

$\sim 40$ km destruction radius
Barringer Crater: \(\sim 50 \text{ ky BP}\)

M-type asteroid: \(D \sim 50 \text{ m}\)

\(\sim 10\) megaton impact

1.2 km crater diameter
Chicxulub Crater: ~65 My BP

Asteroid: $D \sim 10$ km

180 km crater diameter
Comets and Meteor Showers

Comets shed dust and debris which slowly spread out as they move along the comet’s orbit.

If the Earth encounters one of these trails, we get a meteor shower.
Perseid Meteor Shower
Major Meteor Showers

Radiants of 39,208 meteors observed by SonotaCo Network in 2007-2008

Forty Thousand Meteor Origins Across the Sky
Known Potentially-Hazardous Objects
Origin of Near-Earth Objects (NEOs)

Some fragments wind up on orbits which are resonant with Jupiter.

Their orbits grow more elliptical, finally entering the inner solar system.
Asteroid Families

Many asteroids are members of **families**; they have similar orbits and compositions (indicated by colors).

Inner belt asteroids (left) and families (right).
As smaller bodies in the early Solar System fall together, the asteroid agglomerates. Heavier elements sink to the center as the asteroid heats. This forms a separate core, mantle, and outer crust. Lava from the interior flows to the surface. Occasional impacts with other bodies break off pieces of the crust, exposing the mantle.

Hubble Maps the Ancient Surface of Vesta
Chicxulub Impactor: A Possible Timeline

1. Baptistina parent body (170 km diameter) smashed ~160 Myr ago.

2. Fragment hits Moon, forming Tycho crater (110 Myr ago).

3. Fragment hits Earth, forming Chixulub (65 Myr ago).