Deep Impact the Movie
Science Fact vs. Fiction

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Session 34 – 1/19/05
Science Fact vs. Fiction

- Deep Impact, the Movie
- Armageddon
- Themes:
  - comet/asteroid is about to impact Earth
  - What we can do to avert disaster
Deep Impact Facts

- Nucleus Split in two
  - Diam$_1$ = 1 mi $\rightarrow$ $r = 0.8\text{km}$
  - Diam$_2$ = 6 mi $\rightarrow$ $r = 4.8\text{km}$
- Rotation period 14 hr
- Earth collision $r = 1\text{AU}$
What the Movie Got Right

- Comet Appearance
- Impact Energetics
  - \( E = 0.5 \text{ m} v^2 \)
  - \( v^2 = GM(2/r - 1/a) \)
- Global consequences
  - 1 km radius major
  - 4.8 km catastrophic

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<tbody>
<tr>
<td>0.8</td>
<td>( 2.2 \times 10^{12} )</td>
<td>( 1.9 \times 10^{19} )</td>
<td>3200</td>
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<tr>
<td>4.8</td>
<td>( 4.7 \times 10^{14} )</td>
<td>( 4.1 \times 10^{21} )</td>
<td>690,900</td>
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Historical Impacts

- Lunar evidence
- Barringer crater, AZ ~ 50,000 yr
- 1972 Fireball, Tetons
Historical Impacts

- **Tunguska (1908)**
  - 30m radius
  - 8 km explosion area

- **KT Impact (65 Myr)**
  - Crater 10-15 x meteorite size
  - Extinction of 50% of species
  - Storms and fires
  - Atmospheric dust → months to clear

*Each blue dot below represents a cenote such as the one to the left.*
Chicxulub Crater – Yucatan

- Crater discovered 1950’s oil survey drilling
  - Ground water seeping → limestone → Cenotes
  - Diam 145-180 km
  - 10 km diam; $10^8$ ton TNT
Global Effects

- Debris into Atmosphere
  - Greenhouse gases (CaCO₃ = limestone)
  - Forest fires & “Nuclear Winter”
- Yucatan during Cretaceous → shallow sea
  - Tsunami – 100m high wave
Craters on Earth
What the Movie Got Wrong

- Observing with lights on
- Orbit determined from single data point
What the movie got Wrong

- Boulders in Tail
  - Largest: cm-sized
  - \( a_{\text{crit}} = c \frac{Q v_{\text{th}}}{\rho_g \rho_{\text{nuc}} R_{\text{nuc}}^3} \)

- Outgassing at sunrise
  - Heat slowly penetrates
  - No instantaneous jets
What the movie got wrong

- The tidal wave
  - Impact velocity 70000mph
  - Tsunami 500-1000 km/hr
  - Deepwater waveht 1km: 6-35m (10x @ 100 km)
- “runup” height greater
  - Factor of 2-3 (conservative)
  - Factor 25-40 Hawaii
- Empire state: 443.2m
Armageddon

- **Right:**
  - Thrusters for gravity
  - Impact in Paris

- **Wrong:** All else
  - Discovery TX-sized
  - Comet or Asteroid?
  - Scheduling HST
  - Meteor stream radiants
  - Particle size Distribution
  - Asteroid “Composition”
Armageddon (contd).

- **Composition:**
  - If asteroid (metal): Ni or Fe
  - Density 7000 kg/m$^3$
  - Easy to drill
  - Form from differentiation
  - No volatiles! CH$_4$