

Impactos de Objetos del Espacio

Meteoritos y Asteroides Alguna nomenclatura

Los objetos espaciales que chocan con la Tierra, han llegado principalmente de la fragmentación de asteroides y cometas. Como la cantidad de desechos espaciales antropogénicos está aumentando, la posibilidad de que algunos objetos hechos por el hombre tiendan a reentrar a nuestra atmósfera aumenta. La mayoría de los objetos son lo suficientemente pequeños que se desintegran al entrar en contacto con la atmósfera, sin embargo algunos fragmentos más grandes pueden golpear la superficie de la tierra, (por ejemplo, el transbordador espacial Columbia, 28 de Octubre de 2003). Meteoritos entran a la atmósfera terrestre todos los días con una velocidad de más de 10 km/segundo. La mayoría de estos se quema en la atmósfera y nunca logra chocar contra la tierra. Eventos como el caso de Tunguska (ver más abajo) sucede muy rara vez, tal vez una vez cada 300 años.

- **Meteoroide:** fragmentos de asteroides y cometas que orbitan alrededor del sol; pueden interceptar la órbita del planeta tierra y chocar; un meteoroides de piedra (stony) de 10 metros de diámetro puede producir una explosión de unos veinte kilotones (bomba Hiroshima).
- **Meteoro:** Estrella fugaz, el fenómeno de la luz cuando un meteoroides entra a la atmósfera de la tierra y esta se quema.
- **Meteorito:** el fragmento que sobrevive el viaje a través de la atmósfera y golpea el suelo;
- **Lluvia de meteoros:** inusual ocurrencia frecuente de estrellas fugaces, sucede un par de veces al año, pero los eventos más espectaculares son las Perseidas de Agosto 12, la Leónidas el 17 de Noviembre y el Gemínidas en Diciembre 14 de cada año; la lluvia de meteoros son causadas por pequeñas partículas de polvo (la mayoría más pequeños que un grano de arena) entrando y quemándose en la atmósfera de la tierra, las partículas de polvo fueron expulsadas cuando los cometas interceptaron la órbita terrestre, a excepción de la Gemínidas que son causadas por los restos de un asteroide.
- **Boloide:** es un cuerpo extraterrestre que choca con la tierra o por otro lado un excepcionalmente brillante meteoro en forma de bola de fuego

Meteoritos

- **Hierro (metálicos):** se cree que se asemejan al núcleo de la tierra
- **stony (rocoso):** se cree que se asemejan al manto de la tierra; son menos comunes por que existen menos probabilidades de sobrevivir el viaje a

través de la atmósfera, una vez en el suelo, estos se erosionan más rápidamente que los meteoritos de hierro (se confunden con piedras).

- Un estimado de 500 meteoritos alcanzan la superficie de la tierra solo entre 5 y 6 son recuperados y se ponen a disposición de los científicos.
- La mayoría de los meteoritos de hierro se cree que proceden de asteroides que fueron inicialmente lo suficientemente grandes como para diferenciarlos (ver lección 3)
- Tektitas: objetos vídriosos, por lo general, tienen unos cuantos centímetros de diámetro, se forman cuando un gran meteorito golpea la superficie de la tierra y funde las rocas en su entorno.

Ejemplos de algunos cráteres de impacto de meteoritos de hierro²

- Cráter del meteorito Barringer: Cerca de Flagstaff, Arizona; 1200m de diámetro, 170 metros de profundidad, rodeado por 45 de alto hasta el borde de la piedra; se cree que se hizo hace 50.000 años; 50 metros de diámetro; el fragmento más grande recuperado pesa 640 Kg; el impacto tuvo una velocidad de 10-20 Km/s; El impacto produjo una explosión equivalente a por lo menos 2.5 megatoneladas de TNT (150 veces Hiroshima); produce un terremoto de una magnitud estimada de 5,5 o superior; toda la vida murió instantáneamente dentro de los 3-4 Km a la redonda; la onda de impacto niveló todo alrededor de 20 kilómetros, pero no impactó seriamente el clima de la Tierra; la recolonización de la flora y la fauna probablemente se darán en 100 años.
- Odessa Meteor Crater: TX; southwestern Ector County; largest of several craters in the area; craters may have come from fragmented asteroid; created 50,000 yrs ago; 168m diameter; originally 30m deep; currently 5m deep (filled due to erosion and sedimentation); largest recovered piece 300 pounds
- Wabar Craters: in Rub' al Khali desert in Saudi Arabia; three prominent roughly circular craters, 116, 64 and 11m wide; age estimated at 140 yrs (Earth Impact Database); meteorite mass 3500 tonnes; largest fragment recovered 2.2 tonnes; impact speed 11 - 15 km/s; biggest piece struck with force of Hiroshima bomb
- Wolfe Creek Crater: Western Australia; 875m diameter; less than 300,000 yrs old; 50,000kg meteorite
- Tunguska event: Central Siberia; explosion in atmosphere 5-10km above surface, no crater; 1908; trees felled by blast in atmosphere; blast estimated at 10-20 megatons TNT (equivalent to most powerful ever nuclear

bomb detonated by U.S. Castle Bravo/Bikini Atoll); bright bluish light noticed at Lake Baikal, 200km away; associated shockwave knocked people off their feet several 100km away; pressure fluctuation large enough to disturb barometers in Britain; in U.S. decrease of atmospheric transparency for several months; association of glass spheres found in area to event uncertain as area is a volcanic region that could produce them; whether source was an asteroid or comet is under debate; a comet could disintegrate more easily in the atmosphere and could produce a skyglow; a later discovered meteor shower seems consistent with the notion that the Tunguska body was a piece of Comet Encke though others argue a comet could not have survived as long as the Tunguska body apparently did; others suggest that the arrived from the direction of the asteroid belt

Asteroids

- asteroid belt between Mars and Jupiter: small (under 1000km) rocky, metallic and icy masses
- orbit where a 10th planet should be
- gravitational pull of Jupiter may have prevented planet formation
- Kirkwood Gaps: asteroid belt has gaps which distances relate to orbit time of Jupiter
- most are too small for gravitational forces to form a spherical body
- some asteroids may actually be more than one body, held together loosely by gravitational forces
- the three largest (Ceres, Pallas, Vesta) make up about half of the total mass in the asteroid belt
- all asteroids together would make a body with 1500km diameter, less than half the size of the Moon
- a group of asteroid (Apollos) have Earth-crossing orbits and another (Amors) have Mars-crossing orbits and come close to Earth's orbit
- Apollos and Amors provide asteroids that impact on Earth

Comets

- have extremely elongated orbits around sun

Table 1: Size of Asteroids

Name	number of bodies	diameter/km
Ceres	1	933
Pallas	1	523
Vesta	1	501
	200	>100
	1000	>30
	1,000,000	>1

- "dirty snowballs" consisting of ice and rocky debris; core and tail; tail forms when sunlight and solar wind heat and ionize material; comet then ejects gases and trapped dust that appear as the tail; most have cores less than 15km across; orbit may be changed by pull of planets when it enters the solar system; when comets cross Earth's orbit, the debris left behind by the tail is the source for sometimes spectacular meteor showers
- contain carbon compounds, N, H, O; some scientists think that comets are a major source for organic material and water on Earth
- divided into short-term and long-term comets, referring to their re-occurrence
- short-period comets: orbits in less than 200 yrs; come from Kuiper Belt; probably remains from when outer icy planets formed; some examples: Halley (75 yr period; core 15km across; only naked-eye comet certain to return within human lifetime), Encke (a few yrs; core 1-3km across; might be piece of a larger Bronze-age comet that destroyed Fertile Crescent/produced crater in Iraq); Biela (6yrs); Tuttle (13.5 yrs; responsible for Ursids meteor shower in late December)
- long-period comets: most comets are long-period; come from far beyond Solar System; originate from Oort cloud; some examples: Hale-Bopp (1997, discovered in 1995; core 40km across); Hyakutake (1996, discovered in Jan, passed very close to Earth in Mar; one of the closest cometary approaches in 200 yrs; first-time discovery of X-ray emission; longest tail yet known for a comet; used to have period of 15,000 yrs but now has 72,000 yrs after passage through solar system; core 2km across)
- Kuiper Belt: flattened disk beyond Neptune out to 50 AU; source of short-period comets; outer edge thought to be defined by interaction with Neptune; Pluto and the larger Eris, and Neptune's Moon Triton are considered Kuiper Belt Objects (see also Lecture 3)
- AU: astronomical unit; Earth-Sun distance; 150 Mio km (93 Mio mi)
- Oort cloud: cloud about 50,000-100,000 AU from sun; source of long-period comets; no direct observation of cloud but dimension and existence

estimated from orbits of comets; thought to be remnant of original nebula from 5 billion years ago

Large Impacts

- thought to be rare events: e.g. a 1m impactor happens once a year but a 100m impactor happens once every 10,000 yrs and a 10km diameter impactor happens once in 100 Mio yrs
- large impact cause mass extinctions
- some consequences of large impacts:
 - large crater
 - gigantic earthquakes and aftershocks; e.g. the K-T impact was an estimated magnitude 11.3
 - uncontrollable wildfires; e.g. the K-T impact caused consumption of much of the vegetation in N. America, India, equatorial region
 - huge amount of NO₂ in atmosphere would cause acid rain
 - dust and aerosols in atmosphere would block sunlight, increase albedo, cooling climate and inhibiting photosynthesis for weeks to months
 - increased CO₂ in atmosphere would lead to global warming for years, after dust settled
 - up to 300m high tsunami, if asteroid hit oceans
 - huge amount of steam carrying debris high into atmosphere, if asteroid hit oceans
 - additional CO₂ into atmosphere, if asteroid hit coral reefs in shallow tropical ocean

Torino Scale

Shows potential threat and magnitude of hazard by approaching comets and asteroids. The scale goes from 0 (no collision hazard) to 10 (collision will cause global catastrophe). Currently there is no known object to have a value higher than 0 for the next 100 years check at NASA. However, some impactors may not be discovered until a short time before intersection.

- Levy-Shoemaker comet: plunged into Jupiter's atmosphere between July 16 and July 22, 1994; was unknown before March 24, 1993 when Carolyn and Eugene M. Shoemaker and David Levy discovered it with a telescope of the Mount Palomar Observatory. Impact speeds were estimated at 60km/s. The comet was orbiting Jupiter rather than the sun, with an orbital period of about 2 yrs. Prior to its capture by Jupiter, it is assumed to have been a short-period comet, with an aphelion just inside

Jupiter's orbit and a perihelion in the asteroid belt. It is believed that it disintegrated into several pieces during a close encounter with Jupiter in July 1992, the largest piece being 2km across.

Space Age and Space Debris

- The space age and related launches of ever growing numbers of rockets increases the threat of impacts by human-made space objects. Many burn up in the atmosphere but some may make into to the surface. impacts by failed launches: launches are hazardous because rockets are full to capacity with fuels; some have nuclear reactors on board, so pose particular threat;
 - some examples: NASA/ESA launch in 1990 of unmanned solar probe Ulysses was controversial because it has a nuclear power generator
 - Russia launch of Mars space craft Mars-96 from Baikonur/Kazakhstan crashed into the Pacific Ocean between Easter Island and Chile during its third revolution around Earth after the third stage of the launch rocket failed; the spacecraft had a nuclear reactor on board
 - 1998 Russia launch of 12 American (Globalstar) communications satellites in Baikonur/Kazakhstan failed 4.5min into launch; the rocket and satellites are believed to have crashed in the Khakasskaya region north of the Altai mountain range in Siberia
 - Russian launch of a solar sail space craft from Mir space station in 1999 jammed and burnt up in atmosphere
 - Russian launch of a solar sail space craft in 2001 burnt up in atmosphere due to failure of booster
 - Russian military communications satellite "lost" on June 21, 2005, six minutes into the launch; according to experts, the satellite either "fell into a forest with the rocket's third stage or self-destructed"
 - joint Russian/U.S. launch of a solar sail space vehicle crashed back to Earth on June 22, 2005, two minutes into the launch; the rocket was launched from a nuclear submarine in the Barents Sea
 - Russian launch of European telecommunication satellite in Baikonur/Kazakhstan crashed on July 26, 2006, when the Dnepr rocket crashed shortly after blastoff. Kazakhstan banned further launches of Dneprs until the cause of the crash was determined, out of concerns over pollution. The next launch (successful) followed only 10 days later

DID YOU KNOW? 27,680: The number of objects sent into space between 1957-2002; 18,669: number of those burnt up (in atmosphere); 9,011: objects still in orbit; of these, 6,115 are space debris
only 10% of all objects launched into space are still functioning¹

Table 2: Number of space launches by country (1957-2003)¹

Country	Number of Launches
USSR	2289
Russia	354
USA	1261
France	161
China	68
Japan	57
India	11
ESA*	6
Israel	4
UK	1

*ESA: European Space Agency

Related Web Sites

- NASA: National Aeronautics and Space Administration
- ESA: European Space Agency
- Earth Impact Database

References

1. (1) "The Penguin State of the World Atlas" by Dan Smith, 2003. Penguin Books, ISBN: 0-14-200318-2
2. (2) Wikipedia site