appeared in 2003

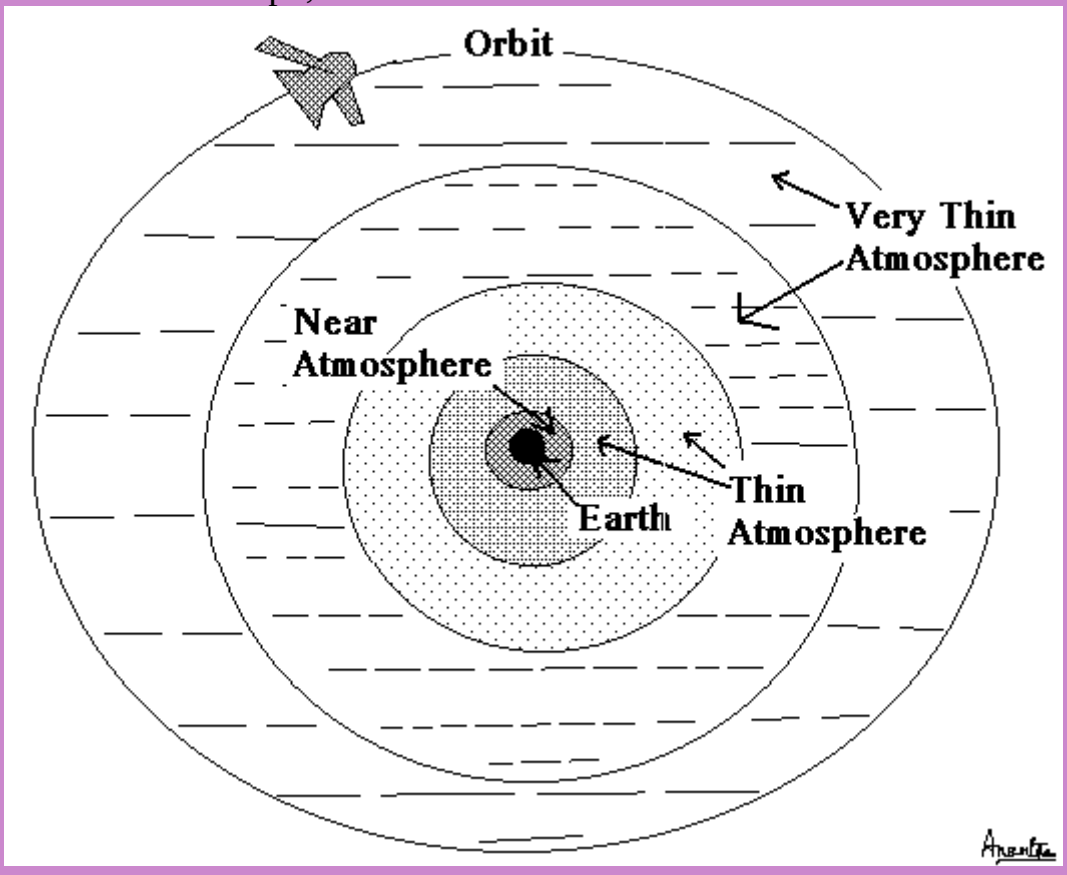
Hot time getting down to earth

The tragic end of the Columbia on Saturday (1st Feb 2003) seems to be because of heat during re-entry, says S.Ananthanarayanan

Heat is generated due to friction, of the spacecraft hurtling down rubbing against the thin atmosphere at high altitudes. Is it surprising that this should generate so much heat?

Friction depends on speed

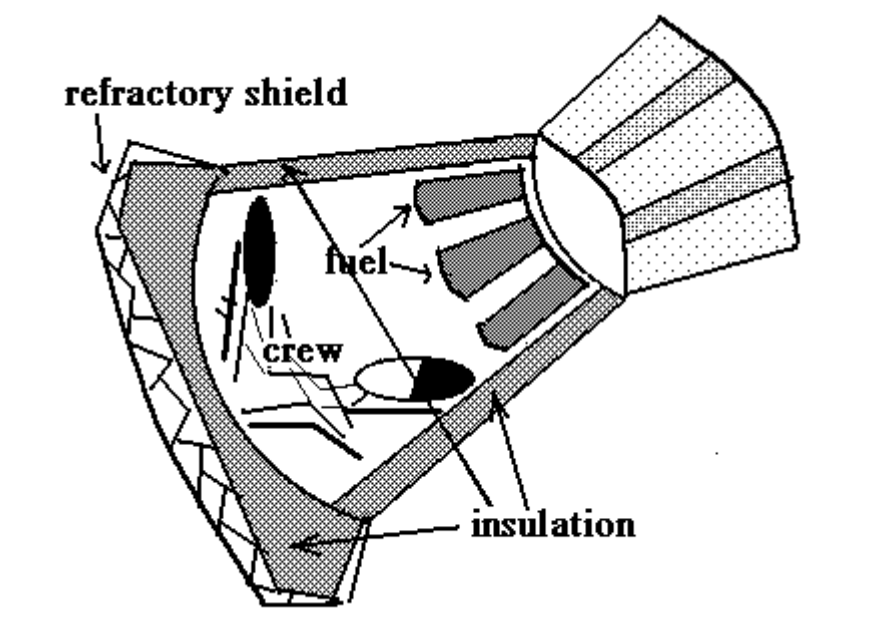
The thing about friction is that it increases not just with speed, but by the square of the speed of the things rubbing against each other. This means that the friction when the speed is 10 kmph is not just 10 times the friction at 1 kmph, but 100 times as much. And a spacecraft falling to the earth from orbit comes in at many times the speed of sound, or at thousands of kmph! Those who have been in a storm can imagine the force of a 100 kmph wind. At even just the speed of sound, which is about 1000 kmph, the resistance would be about 100 times as much.



At many kilometers above the surface of the earth, no doubt, the atmosphere is much thinner. Even so, as speeds are phenomenally high, several thousand kmph, and over the many minutes of fall, the leading end of the spacecraft heats up to many hundreds of °C. In fact, it is thanks to just this friction in the upper atmosphere that asteroids, or shooting stars, get burnt to vapour before they strike the earth! And a very good thing it is too!

The heat shield

For this reason, the leading edge of the re-entering spacecraft has to be made, first, of a material that can withstand such high temperatures. The next thing is that between this leading surface and the insides of the craft, there needs to be a very powerful insulating layer, to keep the temperature tolerable by the occupants. A space shuttle also contains a quantity of fuel, to enable the craft to slow down, reorient and carry out a landing as it approaches the earth. This fuel also needs to be saved from the searing heat.



In addition, a specialized thing like a spacecraft carries arrays of electronics and control and computing systems, which are temperature sensitive and need protection, both from intense cold in outer space and the heat of re-entry.

Risk of impact

The greatest risk to a spacecraft is really from the speed at which it moves. Apart from the intense heat during re-entry, speed also magnifies the danger of an impact

with a mere pebble or even a piece of fluff. The weight of a table tennis ball, for instance, is 2.7 grams. But at 4000 kmph an impact with a table tennis ball is like being hit by a cricket ball (140 grams) at 75 kmph. Now, the speed of a shuttle, in orbit at 300 kms above the earth's surface is a whopping 25,000 kmph and the Columbia, at the time of the mishap, about 75 kms above the earth, was moving at 20,000 kmph!