Background information

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The re-entry of the ROSAT satellite and the risks

Space debris comprises all man-made objects currently either in orbit around the Earth, or in the process of re-entry to Earth's atmosphere, that no longer serve any useful purpose. Primarily, that means satellites, operational and non-operational, the upper stages of the rockets that lifted these satellites into orbit, as well as mission-related objects needed to get the satellites into orbit, but which do not in their own right serve any other purpose. Finally, there is a range of space debris, basically just in bits and pieces. Case in point: the cooling fluids released by Russian reactors, not to mention slag particles released by solid fuel rocket engines. At present, about 6700 tons of space debris orbit the Earth. ROSAT, weighing just 2.4 tons, constitutes just a tiny part of that total. Since the days of Sputnik, about 27,000 tons of material have been sent into space, and have re-entered our atmosphere. None of these objects has caused serious damage, neither to people nor to property of any kind, despite the fact that, in the past, there have been quite a few large 're-entry objects'. One example is Skylab, which re-entered back in 1979, weighing about 80 tons. The list also includes Salyut 7, back in 1991, weighing about 40 tons, as well as the MIR space station, weighing about 135 tons.

ROSAT, like every other object larger than 10 centimetres in near-Earth space, is tracked on a regular basis by the US space monitoring system. The key factor governing the timing of re-entry is solar activity. This solar activity, as the name indicates, originates in the Sun, or more specifically from sunspots that emit high-energy radiation, which is absorbed by our atmosphere and converted into heat. This heat enables layers of Earth's atmosphere to climb to higher altitudes, and at these higher altitudes, these atmospheric layers help to slow down the satellite. This all occurs on a cycle lasting about 11 years.

But the current solar cycle is quite an abnormal one because activity is still below the anticipated level. Right now, the level of solar activity should be at a maximum, but it is not. This is why the re-entry of ROSAT has been delayed by more than a year.

When launched, ROSAT was sent up into a relatively low orbit, at an altitude of about 550 kilometres, and at an angle relative to the Equator of about 53 degrees. ROSAT is now slowly going to descend from that orbit. This slow descent is due to the friction encountered by the satellite as it enters the outer fringes of Earth atmosphere, which increases the more ROSAT penetrates into our atmosphere. This phenomenon is also referred to as an 'exponential increase in density'. Once ROSAT reaches an altitude of 150 kilometres, it is reasonable to assume that it will not remain up there for more than a day. Once ROSAT reaches an altitude of between 120 and 110 kilometres, it is reasonable to assume that it will not remain up there for more than one orbit.

In the final phase, ROSAT will be 'caught' by the atmosphere at which point it will not even complete an orbit around the Earth: instead, it will go into 'free fall'. The rate of this free fall encounters the powerful braking effect of residual atmosphere, causing the speed of the satellite to decay. This process of slowing down consumes vast amounts of energy that is released in the form of heat. The maximum heating takes place at an altitude of 80 kilometres. Shortly thereafter, maximum retardation takes place.

All these forces exerted on the satellite cause it to disintegrate, which in turn means that it eventually lands in the form of a long debris trail. The lightweight objects fall to Earth first, similar to leaves from a tree. The really heavy objects land later, because they ultimately have to drill their way through the atmosphere. Generally speaking, whenever a satellite re-enters the atmosphere, about 20 to 40 percent of its mass actually reaches the Earth's surface. In the case of ROSAT, this figure could be slightly higher because one of its characteristic features is that it carries heat-resistant mirror structures on board. Which means that more than 20 to 40 percent of its total weight could reach the ground.

The probability that ROSAT will strike German territory after re-entry is roughly to the order of 1:580. The risk of someone in Germany getting injured is to the order of about 1:700,000.

It is not possible to accurately predict ROSAT's re-entry. The uncertainty will decrease as the moment of re-entry approaches. It will not be possible to make any kind of reliable forecast about where the satellite will actually come down until about one or two hours before the fact. It will however be possible to predict, about one day in advance, which geographical regions will definitely not be affected. One day before ROSAT re-enters, we will be able to predict it's landing moment with an accuracy of within +/- one orbit. At that point, we will know which geographical regions will not be affected by the return to Earth of this satellite. If Germany happens to be one of these exempt areas, we will be able to stand down this warning.