What was that bright glow in the sky?

One evening after sunset you see a very bright glow in the sky, seemingly a long way away. It seems to last for more than a second before quickly fading. You listen for a rumble. None can be heard. What's going on? You quickly reject 'act of God' or 'act of war'. Industrial accident? Unlikely, for it's too high up and there is no likely culprit. Aviation disaster? Possibly, but the light is bright and not obviously all in one spot. Lightning? The weather doesn't seem right; it lasted too long and there was no repeat. The most likely explanation is that it was something from space entering the Earth's atmosphere and burning up.

Our atmosphere is for breathing. Our atmosphere is for weather. Our atmosphere is also a vital shield. What attack is it shielding us from? Not aliens, though it might help, but a range of assaults that, unlike aliens, are certain to arrive. Without our atmospheric shield, life as we know it could not be sustained. There is serious talk these days of humanity on the Moon, humanity on Mars or even humanity on asteroids but on none of these places can we live without the kind of shielding our atmosphere provides.

Galileo doesn't often get the credit he deserves for pointing out that if you are in a closed compartment you can't tell how fast you are moving, or even if you are moving at all. Half a century later this was seen to be a consequence of one of Newton's laws of nature. Galileo had in mind the cabin of a ship but the same applies to spaceship Earth. We just can't feel that we're moving in our orbit around the Sun at over 100,000 km per hour. It really doesn't feel as if we're moving at all. It is this motion of the Earth, and other bodies in the solar system, that causes us serious problems.

When we think of space we often think of emptiness. It's a false association. Space is full of 'stuff', all hurtling around generally not at the same speed as we are, or if at the same speed then not necessarily in the same direction. Fortunately for us, this has been going on in the solar system for the 4.6 billion years of the Earth's existence and most of the stuff that was going to collide with Earth has already done so. There's not nearly so much out there as there used to be.

There are two other comforting facts. First, space is big. Even the solar system is big so there is lots of room for 'stuff'. Secondly, everything in the solar system isn't flying about at random but is moving in well-defined orbits that are largely determined by the gravity of the Sun. For collisions to happen, not only do orbits need to intersect but the orbiting bodies need to arrive at the intersection point at more or less the same time. So we're pretty safe then?

Well, actually, we are pretty safe. You'll scarcely find a large crater on Earth that has been formed in the last million years. Since the sea covers two-thirds of the Earth's surface it is the most likely place of impact. The most conspicuous 'recent' crater is the Barringer crater which was formed 50,000 years ago in Arizona. It's about 1.2 km wide and 170 m deep. Impressive enough, and devastating if such an impact occurred in a city but cities don't occupy much of the world's surface. I'm not losing any sleep over the possibility of being wiped out by an asteroid strike, for you could fill pages with events more likely to be the cause of my demise.

Forget about the big stuff. It's the little stuff that's still out there in swarms: fragments of comets, debris from asteroid collisions, 'dust' that never aggregated to form anything bigger.

As a rule of thumb, the smaller the pieces, the more of them there are. Within limits, the numbers increase approximately exponentially as the size decreases, in what is often called 'a power law'. The Earth sweeps up several thousand tonnes a year of tiny grains of rock and metallic fragments. They burn up in the thin high atmosphere creating meteor streaks at night. Occasionally larger fragments more than a centimetre in size make it lower down. As the atmosphere thickens along their path they may splinter into a shower of fragments that will burn up in seconds. The resulting light can be seen for a hundred kilometres if it's high enough. This is the likely reason for a fleeting bright light in the sky. Mankind has added to the influx by creating tens of thousands of pieces of 'space junk' in decaying orbits. The lowest objects will spiral into the atmosphere but they haven't the speed of meteoroids and need to be larger to make a show. These larger objects are tracked and their flight paths known so it's likely to be in the news if one of these is responsible for bright lights in the sky.

All of the above is less than half the story of why our atmospheric shield is essential for life on Earth. We think of the Sun as the staff of life. It gives us heat; it gives us light; it gives us rain and plants; it gives us energy. But all is not as it seems. It is only the sun's rays filtered by the atmosphere that are so benign. The raw Sun is the staff of death. The Sun is a bright enough star that some 7% of its radiation is in the ultraviolet. We can't see in the ultraviolet and what we can't see we tend not to think about. The fact is that any life exposed to the ultraviolet that reaches the outer atmosphere of the Earth would be scorched and biodegraded very quickly. The stratosphere absorbs all the very harmful ultraviolet, letting only a fraction of the less harmful (but not quite harmless) UV reach ground level.

Ultraviolet can be stopped by a thin wall but what makes the raw Sun a real killer of complex life is the combination of the solar wind and coronal mass ejections. As we found in the second half of the twentieth century, the Sun does not just emit radiation but it emits streams of very energetic particles, a plasma of electrons and highly charged nuclei whose particles travel at hundreds of km per second. Yes, per second. This flux is always present but it can flare up by more than a factor of a thousand. Thin walls are quite insufficient to absorb the energy of these emissions. At least a metre thick of concrete or the equivalent is what is needed. That's what our atmosphere provides – in fact the equivalent of a few metres thick of concrete. Above every square metre of ground is a pillar of atmosphere with a mass about 10 tonnes. That's the mass of about 4 metres thick of concrete.

It's not just mankind that benefits from the global umbrella shielding us from a rain of solar nastiness. It's all of life on the surface of the Earth. Could we lose our protective atmosphere? It's not likely, for the Earth's gravity is what holds the atmosphere close to the surface. Look around, though, and Mars has too little atmosphere to provide a good shield for life, even though it is further from the Sun. Venus has so much atmosphere that it traps solar heat making the surface a hundred degrees Celsius above the melting point of lead. Pluto is so cold that its atmosphere has mostly condensed out. Mercury and the Moon have no atmosphere worth speaking of. Mankind may live in many parts of the solar system in a thousand years' time but it won't be the kind of life we now take for granted.

Our thoughts may have come a long way from a bright light in the sky but there is one more light in the sky that reminds us that the Earth has another shield protecting its life. That light is the aurora, visible in Scotland on several clear dark evenings in a year and more frequently

further north. The aurora is a result of energetic solar plasma being deflected by the Earth's magnetic field round past the Earth to the night side. This deflection saves some of our atmosphere from being stripped away by the solar plasma. It also results in energetic particles spiralling down the Earth's magnetic field lines from the dark side towards the magnetic poles, causing the very high atmosphere to glow. It's wonderful to watch and a reminder that life is doubly protected on Earth, by our atmosphere and by our magnetic field. You won't find that on any other solid body in the solar system.

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