Why do we seem to be alone?

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We may be located at an apparently random place in the Universe but if you look around on almost every scale you'll see that we could be in a lot worse a place. We could be on a world that's permanently covered in cloud or haze. Take Venus or Titan, to name two nearby examples. How much would we know of the Universe then? Instead of being about eight kiloparsecs from the centre of the Milk Way, we could have been much nearer the centre, either enveloped within interstellar dust or exposed to high levels of electromagnetic radiation from a variety of mechanisms, or too near a massive star that blew its heart out in a supernova explosion. In fact the more you look around the Universe, the more it becomes apparent that it's not a great place for life. Almost every part of the Universe is either too hot or too cold, debris is whistling round at tens and even hundreds of km per second, impacting whatever comes in its way, electromagnetic radiation and other hazards all make life unimaginable in many parts of every galaxy. What fraction of the Universe is like the Earth with blue skies, fecund seas, sunny beaches, heather clad mountains, productive fields and forests? A precious small fraction. In fact, so far we've found nowhere else. There can't be a much stronger incentive for looking after the Earth.

I used to wonder, as you probably do, 'why haven't we seen evidence for other intelligent life in the Universe?' If you're a believer in abduction by aliens using flying saucers, then the question is a non-starter. For most of us, though, it's a good question. My take on it is both physical and philosophical.

First, the physical reasons. It's only in the past few decades that mankind has realised what an enormous place the Universe is - enormous but almost empty: empty of matter and empty of energy. The universe at large is not a place where the complexity of life thrives. It is mainly a cold, dark and empty place except in isolated and widely separated regions. The stars are too hot for life, too hot in the most part for even molecules to exist. Active life, which I take it is a pre-requisite for intelligence, can potentially exist in narrow shells a few light minutes across around stars, where the temperature is about right. Stars themselves are typically light years apart. It is possible that alien civilisations can launch intelligent life away from their origins in these habitable shells, but life-sustaining capsules need adequate energy to travel for large amounts of time in the cold and dark of space. However that may be, in short the gigantic vistas of space and the low density of matter in space both dictate that advanced life that develops separately is likely to be a very long way apart.

The violence that exits in our Universe is hard, very hard, to grasp. I'm not thinking here just of large objects hurtling around at high speeds, or of the violent, turbulent, super-heated conditions that exist within every star we can see. I'm thinking at the moment of the evidence presented to us by the rising discipline of γ-ray astronomy.

Over the past decade, γ-ray astronomy has opened a new window on the universe. The view from that window is of a universe peppered with events of extreme violence. Let me give you a couple of examples. A small Geiger counter such as you or I might use to check radioactivity in the environment is designed to detect γ-rays. If you find a significant count rate a couple of metres away from a radioactive source then that source will be seen as a potential hazard to health. The full weight of the legislation connected with the Environmental Protection Agency will be brought in to deal with the matter. Astronomers

have built devices to detect cosmic γ-rays, in fact γ-rays much more energetic than ever come from radioactive sources. Do they find anything? Indeed they do. They detect γ-rays in large numbers. Astonishingly, some of the sources of very high energy γ-rays are over 500 million light years away. Some are even over 1 billion light years away, the 'record' being some 13 billion light years, near the limit of the observable universe. A single light year is an almost unimaginably large distance in terms of any distance we are used to thinking about on Earth. It's over a billion (10^9) km. To detect γ-rays from sources over 500 million light years away beggars belief. You can put a number to the energy emitted by such a violent source but words fail. If we can detect the radiation at 500 million light years distance then it fills an enormous volume in the Universe. Imagine being much nearer such a source, where the radiation is very much stronger. γ-rays in serious doses are detrimental to life, which is why the Environmental Protection Agency are concerned about radioactivity. γ-ray sources in the universe have made swathes of the universe unfit for life.

We believe that here on Earth we are a long way from any life-destroying γ-ray sources but sometimes out of the darkness can spring the unexpected. For example, on 27th December 2004 γ-ray astronomers detected such as strong burst of γ-ray rays that many counters were briefly overloaded. The ensuing detective work on the cause concluded that a rupture in a neutron star had triggered such a burst of energy that in 0.2 seconds the star emitted as much energy as our Sun does over a quarter of million years. The Sun emits a prodigious amount of energy every second. Again, numbers can tell us the violence of the outburst from the star but words fail. Violence like that is intermittent and so are objects flying about at high speed. Life needs continuity to survive and evolve, continuity that is best provided by a spot well sheltered by chance, if nothing else, from intermittent violence of extreme ferocity.

It's hard to exaggerate the challenge to life imposed by the Universe. The Universe is vast, it's cold, the raw materials of matter and energy are incredibly dilute, there is almost no intrinsic complexity in their organisation and mindless violence is rife on almost every scale. The universe at large is not a place for a picnic. Mankind's urge to explore in person has been given a sobering reality check by modern astronomy. Mankind might, with a semblance of global co-operation, make significant inroads into visiting the solar system in person over the next few centuries. The Universe at large is a challenge of a different order. It is quite likely a challenge that alien civilisations well ahead of ours elsewhere in the galaxy have failed to solve and we should probably be thankful for that. Indeed, our unmolested existence on Earth is almost certainly due to the hostility of most of the universe to intelligent life. This fact alone should make us particularly careful not to soil planet Earth, for within any foreseeable future there is no-where else to go.

Having come to a conclusion, need I go on? Adding support to an already firm argument, there are issues of time as well as space. Any kind of life was never going to form early in the history of the universe. The elements from which life is built simply didn't exist. The very atoms of life such as C, N, O, P, S, Fe, Mg and a bit more of the periodic table in small amounts were not present in the early universe. They have taken billions of years to form in reasonable quantity, generated during the evolution of large and medium-sized stars. The elements that might make up 'artificial life', such as Si, Ge, As and Al, if our present day electronics technology develops far enough in this direction, have been no quicker to appear. It will have taken billions of years for the most primitive life to start in the Universe.

As we know from the one example we can probe into here on Earth, it also takes billions of years for intelligent life to form once primitive life has arrived. There are traces of cellular

life on Earth 3.5 billion years old. Life that understands the astrophysics of the Universe is less than a century old. For a start, we need to be orbiting a singleton star that lasts a good few billion years, and stars much more massive than the Sun don't last long enough. We also know that for quite special reasons the Earth has enjoyed an unusually protected history and been spared an assortment of potentially common cataclysmic occurrences that could have wiped out life in several ways. I'm thinking of instabilities in our star the Sun, of an enormous impact by another body, of the supernova explosion of a nearby star that would have bathed the Earth in deadly radiation, or simply a tumbling of the Earth's spin axis over many millions of years that would have caused potentially life exterminating climate changes. We have been spared all these and so it could well be that the appearance of intelligent life in the 4.6 billion years of the Earth's existence is a fast-track time for natural evolution. Don't be surprised if aliens are not living next door. We've almost certainly done well to get this far this quickly.

Finally, there are some more 'philosophical' reasons why we may not have seen intelligent life. First, we may not recognise it when we see it. It may be on a nanoscale; it may be gigantic. We humans have a good imagination but every generation fails to see what later generations think of as 'obvious'. More likely, intelligent life may not want to communicate with us. What would be the point? When you see a baby in a pram you know that your own experience of life and your knowledge of the universe is vast compared with its. Do you stop and try to pass your knowledge on? No, it's pointless, and you really don't speak the same language. The baby will grow up, evolve and learn about the universe in the fullness of time. Maybe intelligent life feels much the same when it has detected the birth of mankind's civilisation and awareness that we are probing the universe. In evolutionary terms, alien life may already have adapted to challenges we've never faced yet and be living a totally different kind of existence.

When humanity finally does travel between the stars to explore strange new worlds, *to seek out new civilisations, to boldly go where no-one has gone before*, if that ever happens, they will certainly discover planets by the millions, almost certainly other forms of life but civilisations will be very rare. Perhaps I've watched too much Star Trek, where the 'prime directive' is that '*there be no interference with the natural development of any primitive society*'. Star Trek is fiction but the code may be a good one for evolved life forms. We, at the moment, are the primitive society. We almost certainly couldn't handle interference by an alien life-form. One can't help feeling that when mankind as we know it leaves the Earth, it will be to create colonies and the 'prime directive' will nowhere be seen.

There's also a more pragmatic reason aliens may choose not to molest us. Planets are very common in the galaxy but the evidence so far is that civilisations aren't. It's been said in jest that surely mankind isn't the best the Universe can come up with. Hopefully not, but my bet would be that it's unlikely we'll find another civilisation within 1000 light years of us. Any race that does develop the technology to visit other planetary systems will have a large choice of planetary systems to visit, even colonise, without having to choose one where a different civilisation has developed. Indeed, it is probably better to colonise an undeveloped planet rather than one in which the indigenous population have shaped the environment for their own ends, already mined the mineral and fuel resources and in general converted the environment from a diverse state to a highly specialised state. To make almost the same point in a slightly different way, why steal an old and worn-out motor when you can steal a brand new one. Forgetting about any moral issues, aliens out to steal a planet for their own use would be

better to colonise one that supported only primitive life, and not the Earth. There are almost certainly plenty to choose from.

Another thought is that a skeleton isn't a useful part of anatomy in space. Indeed, astronauts on space stations circling Earth for only months show skeletal loss in spite of a regime of exercise. Beings like us living for many generations in space are likely to lose most of any skeleton they have. Were they to land on Earth, they'd be as helpless as a jelly fish on a beach. Nice thought, that. Aquatic animals have skeletons for swimming and wouldn't mind zero gravity in a space-ship filled with water, so maybe any aliens that arrive will plunge straight into our bountiful seas. Maybe.

The underlying point is that advanced life as we know it has evolved for a few billion years and thrives in a sophisticated environment with many levels of interlocking complexity, with basic physical needs that are provided by the surface of a planet, such as gravity, an atmosphere, water and so on, all powered by a neighbouring star. You can't take all this with you into space, gravity in particular. Yes, it's possible to have a rotating space station where at a certain distance from the axis of rotation there is any chosen effective gravity but that's a poor substitute for the real thing. The odds are stacked against interstellar travel for intelligent life, however you look at it. On reflection, I'm not surprised we haven't seen alien life. The astronomical distances and the harshness of space as an environment almost preclude travel for sentient beings. Perhaps the best that can be done is to send the seeds of life into space. Seeds, though, don't include encyclopaedic knowledge and they need to be absorbed into the local surroundings when they arrive to grow and develop. After that, they are no longer alien.

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