**Dangerous Cosmology**

*Entry 02*
by Dr Sarah Bosman (CMDR Shobah)

## Rare objects in the Milky Way: Pop II ancestral stars

K and M-type dwarves are relatively boring objects – often surrounded by nothing but well-behaved, inactive icy bodies. Yet, a handful of them conceal a rare and dramatic history: they are only the second generation of stars in the Universe, born in a time before planets and spiral galaxies ever existed! Named 'Population II' stars, we currently know about 20 of them in the Milky Way.

Stars are born in groups. When a large molecular cloud starts fragmenting into stars, it's not long before some of it breaks down into stars of many different sizes, and the rest is blown away. The biggest stars, O and B, are the brightest and dominate the group at first, like the stars we can see around the Omega Cluster, or closer to home, the Pleiades. When the first primates walked the lands of Earth, the Pleiades were likely not yet finished consuming and dispersing their birth cloud… and would have looked more akin to the Orion Nebula in their eyes.

Left: the Pleiades as seen from Earth. The bright, young O/B stars are dominating the group. When the first primates looked up, some of the 'birth cloud' would have likely still been around – making the group look more like the Orion nebula, on the right.

As the biggest stars die off, the small ones survive. A G-type star lives on average for 10 billion years, while the Universe's first stars, we believe, formed about 13.2 billion years ago. Stars of these types, born back then, have all met their demise by now – but not so for the K and M dwarves. With expected lifetimes larger than the current age of the Universe, these galactic fossils still roam the Milky Way today. Or at least, the second generation – born from gas only once recycled – definitely do.

Why not the first generation – "Population III stars"? According to models, being completely metal-free is quite deadly to a star. Iron, Carbon, and Silicon especially, provide a star with a mechanism called "metal cooling" – a way for the star to eject heat into space, rather than keeping it bottled up. Without those elements, all stars, no matter their masses, would have very short lives – unable to mix their internal layers, they would accumulate critical cores very fast. And, since they are very "puffy" from internal over-heating, it's unclear if they would leave *anything* behind when they died other than slightly-polluted gas (although that's very much ongoing research). Even a touch of those metals stabilizes a star – as can be seen in our own Milky Way, with stars which are only 0.00001% polluted ([X/H] < -7). This second generation was born very soon after the first – very likely, while some first gen stars were still around in parts of the Universe.

So, have you run into one of these relics? How would you know? Unfortunately, the exact age is nearly impossible to tell for such pure stars: since small stars evolve so slowly, being born pure 13.2 billion years ago or being born from a pure cloud which waited, by chance, until slightly later to form stars, would look nearly identical. Such pure stars would show up as "Age: Unknown" in the Discovery Scanner, which uses metal content to estimate stellar ages. It wouldn't possess planets except potentially pure gas giants with Hydrogen and Helium. Maybe it would look particularly 'puffed' for its type. Keep an eye out! Exotic stars anyone?

*Dr Sarah Bosman got her PhD in Cambridge for her work on distant quasars. She now works as a cosmologist at University College London in the 'First Light' group, studying distant galaxies as well.*
http://sarahbosman.co.uk