



Chemical Evolution

Dr. Amanda Baker

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From scrutinizing the composition of stars to following the development of galaxies and other celestial bodies, chemical evolution is a fascinating topic of study. It gives insight into the origin and development of chemical elements, compounds and even life.

Astrobiology talked with Dr. Amanda Baker about hot research topics in chemical evolution, astrobiology and what it is really like to be a scientist.

Dr. Baker is an astrophysicist who is currently a post-doc with the chemical evolution group at Cardiff University in the United Kingdom.



Dr. Amanda Baker on holiday! Courtesy Gordon Brignal

Astrobiology: What areas of scientific research are you currently interested in and involved with?

Dr. Baker: The chemical evolution of galaxies: How hydrogen created in the Big Bang forms into pristine galaxies, which are then 'polluted' by heavy chemical elements, particular iron, oxygen and zinc, by the birth, life and death of hundreds of generations of stars.

Active and interacting galaxies: A small fraction of galaxies shine far more brightly than average, and this appears to be due to huge bursts of star formation caused by collisions between galaxies, and to supermassive black holes consuming the galaxy from the inside.

Extrasolar planets: Our understanding of the origin of the Earth and of life is poised to take a huge leap forward, with the discovery and study of planets around other stars like the Sun.

Astrobiology: Why is the study of the chemical evolution of celestial bodies important?

Dr. Baker: We are made of chemical elements such as carbon, oxygen, nitrogen etc. which are formed by stars, particularly in massive stars which burn bright and fast, and in supernovae explosions of dying stars. The study of the formation of chemical elements is one of the fundamental keys of astrophysics, and is also directly relevant to the emergence of life.



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Astrobiology: Astrobiology is a burgeoning scientific field that encompasses many different areas of science (such as biology, chemistry and physics) into a single, broad field. Where does chemical evolution fit into astrobiology?

Dr. Baker: All life that we know is based upon the chemistry of the carbon atom, yet the formation of carbon nuclei from lighter elements requires very rare 'three body collisions' when three alpha particles (helium nuclei) collide. Planets such as the Earth are made from heavy elements such as iron, which are important end-products of nuclear fusion in stars. All chemical elements apart from the very lightest (e.g. hydrogen, helium, lithium etc.) are formed by stars in galaxies. By understanding the details of the formation of carbon in stars in our Galaxy, we can put limits on the times and places where rocky planets and carbon-based life can have formed in our own and other Galaxies.

Astrobiology: What can information gathered from studying the composition of galaxies and the evolution of the abundance of chemical elements in the universe potentially teach us about the origin of the universe and even the origin of life?

Dr. Baker: By taking spectroscopic measurements of very distant galaxies, we can determine the history of star formation within them very soon after the Universe became neutral ('recombination'), as the energy of the Big Bang dissipated. We can therefore understand astrophysical processes which occurred in the very early universe, and hopefully, set limits on the properties of the Universe at such early times.

Astrobiology: What do you enjoy the most about being a scientist? What do you enjoy the least?

Dr. Baker: The most enjoyable aspects are twofold - the amazing concepts I work with every day, and all the interesting people - colleagues,

students, members of the public - which I get to meet as a consequence of being an astrophysicist. The worst part of being a scientist is the abysmal attitude of politicians towards science and academia, which has led to chronic underfunding of UK Universities and left us on the brink of a techophobic crisis.

Astrobiology: How did you become interested in science and space?

Dr. Baker: I always enjoyed maths at school, as was good at it (despite the failings of my teachers!) from the first. I have been interested in astronomy for as long as I can remember - I believe that a friend of my father took me out to look at the stars when I was about 5 years old. I remember Skylab and the Voyager launches, and I became fascinated by the planets of the Solar System. I would like to be the first person on Mars!!!

Astrobiology: What advice can you offer to students interested in pursuing scientific careers?

Dr. Baker: Read and think about the areas which interest you as much as possible. Ask questions all the time, and don't worry if they seem 'stupid' or unpopular. It is important to do well at school, especially in mathematics and statistics, but the most important things of all are imagination, enthusiasm, self-motivation, independence and inspiration! Also, make as many contacts with scientists as you can - ask questions, talk to people, think for yourself!

And don't expect to get rich or even to have a smooth career - academic research in particular is an extremely competitive and poorly paid area of work. Perhaps only 10% of people who do science PhDs in the UK will get permanent jobs in their area of specialization.