How the Milky Way killed off its satellites

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An image of the dwarf galaxy Bootes II, one of 21 known companions to the Milky Way. Credit: V. Belokurov / SDSS collaboration

(PhysOrg.com) -- Two researchers from Observatoire Astronomique de Strasbourg have revealed for the first time the existence of a new signature of the birth of the first stars in our galaxy, the Milky Way. More than 12 billion years ago, the intense ultraviolet light from these stars dispersed the gas of our Galaxy's nearest companions, virtually putting a halt to their ability to form stars and consigning them to a dim future. Now Pierre Ocvirk and Dominique Aubert, members of the Light in the Dark Ages of the Universe (LIDAU) collaboration, have explained why some galaxies were killed off, while stars continued to form in more distant objects. The two scientists publish their results in the October issue of the letters of the journal *Monthly Notices of the*

Royal Astronomical Society.

The first stars of the Universe appeared about 150 million years after the Big Bang. Back then, the hydrogen and helium gas filling the universe was cold enough for its atoms to be electrically neutral. As the ultraviolet (UV) light of the first stars propagated through this gas, it broke apart the proton-electron pairs that make up hydrogen atoms, returning them to the so-called plasma state they experienced in the first moments of the Universe. This process, known as reionisation, also resulted in significant heating, which had dramatic consequences: the gas became so hot that it escaped the weak gravity of the lowest mass galaxies, thereby depriving them of the material needed to form stars.

It is now widely accepted that this process can explain the small number and large ages of the stars seen in the faintest dwarf galaxy satellites of the Milky Way. It also helps scientists understand why galaxies like the Milky Way have so few satellites around them – the 'missing satellites' problem. The stripping out of gas from these galaxies makes them sensitive probes of the UV radiation in the reionisation epoch.

The satellite galaxies are also relatively close, from 30000 to 900000 light-years away, which allows us to study them in great detail, something that will be enhanced by the coming generation of larger telescopes. Comparing the population of their stars in each galaxy with its position could give us a unique insight into the structure of the UV radiation emitted from the earliest stars in the Milky Way.

Until now, models for this process assumed that the radiation leading to the removal of gas from galaxy satellites was produced collectively by all the large galaxies nearby, resulting in a uniform background of UV light. The new model put together by the two French researchers proves this assumption wrong.

Ocvirk and Aubert looked at the way the invisible 'dark matter' that makes up about 23% of the Universe structured itself with the stars in our Galaxy and its environs from shortly after the Big Bang to the present day. They used the high resolution numerical simulation Via Lactea II to model the formation of stars in gas trapped in the dark matter haloes that envelop galaxies, and then to describe how this gas reacted to UV radiation.

Pierre Ocvirk comments, "This is the first time that a model accounts for the effect of the radiation emitted by the first stars formed at the centre of the Milky Way on its satellite galaxies.

'In contrast to previous models, the radiation field produced is not uniform, but decreases in intensity as one moves away from the centre of the Milky Way.

'The satellite galaxies close to the galactic centre see their gas evaporate very quickly. They form so few stars that they can be undetectable with current telescopes. At the same time, the more remote satellite galaxies experience on average a weaker irradiation. Therefore they manage to keep their gas longer, and form more stars. As a consequence they are easier to detect and appear more numerous."

The new model appears to be a close match to observations of our Galaxy and its neighbourhood and suggests that the first stars of our galaxy played a major role in the photo-evaporation of the satellite galaxies' gas, adds Dr Ocvirk. "It is not large nearby galaxies but our own that caused the demise of its tiny neighbours, asphyxiating them through its intense radiation."

More information: The results appear in the paper "A signature of the internal reionisation of the Milky Way?", Pierre Ocvirk and Dominique Aubert, *Monthly Notices of the Royal Astronomical Society*, in press. A

preprint of the paper can be seen at arxiv.org/abs/1108.1193

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