Simple Explanation for Mysterious Observations

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Recently, several astronomical experiments have revealed mysterious components of elementary particles. But up until now, the origin of electrons and positrons is unknown. Is dark matter the actual origin of this radiation, as some physicists speculate?

Now an international team of astrophysicists, including the Bochum junior professor Dr. Julia Becker and the Dortmund physicist Prof. Dr. Dr. Wolfgang Rohde, have found a simple explanation: giant stars, at least fifteen times the mass of our sun, emit elementary particles in a final explosion when they die. The flux of the electrons and positrons calculated on the basis of this theory fits in with the enigmatic signals observed during these astronomical experiments. The six-strong team of international scientists outlines how their theory of supernova explosions explains the observations in the latest edition of *Physical Review Letters* (printed edition on August 7th 2009).

Elementary Particles from the Universe

In connection with various astronomical experiments there have been reports about the observation of mysterious components of electrons and positrons from the universe. The sources of these elementary particles cannot be identified by the experiments alone: cosmic magnetic fields deflect them from their path and cover their tracks. Since these findings were published, there have been several attempts to explain the origin of this particle radiation. Among others, the theory has been put forward

that such a signal can only be explained by the so-called dark matter - a kind of matter whose origin is not absolutely clear yet. “But maybe nature can offer a much simpler explanation for the observed particles” says Julia Becker, who is cooperating with a research team with members from institutes in Germany, the USA and Sweden. The team explains the particle radiation with explosions of giant stars with at least fifteen times the mass of the sun.

The Dramatic Death of Giant Stars

A dying star with a high mass catapults most of its matter, called plasma, in a final explosion into the universe. The result is that the ejected plasma inevitably collides with the matter surrounding the star - the so-called stellar wind. It builds up around massive stars as they lose part of their shell before dying in a final explosion. “During the collision between fast matter from this final explosion and plasma from previous ejections a shock front is formed, similar to the ones that can be observed in case of supersonic aircrafts”, explains the Dortmund astrophysicist Wolfgang Rhode. “When an aircraft flies faster than the sound, the air surrounding the plane is pushed aside with a speed that exceeds sonic speed. A sonic bang occurs, which spreads in the form of a shock front.” The shock front is the point of discontinuous change in density of the medium itself - where the aircraft pushes away the matter the density becomes very high. On the other side of the shock there is the low density of an undisturbed atmosphere. Exactly the same happens when plasma with a high velocity is pushed into slower plasma, as is the case with the giant stars.

Electrons and Positrons Resulting from Supernova Explosions

How electrons and positrons are accelerated in shock fronts of supernova

explosions is explained by the scientists in their article: as the plasma blazes its trail through the stellar wind, two different regions emerge with different shockwaves forming in each region. The magnetic fields of the star are aligned vertically to the velocity of the shock front on almost the whole surface. Here a low-energy signal from the electrons and positrons emerges. At the same time the magnetic field at the poles of the once rotating star is aligned parallel to the velocity of the shockwave. As a result ultrahigh-energy electron radiation is produced. Both components are visible in the observed spectrum of electrons and positrons and the measurements can be explained by the model of the research team. “This means that dark matter this means that it does not produce electrons and positrons in the same amount as giant stars and that one has to look for evidence of dark matter elsewhere” concludes Dr. Becker.

More information: Peter L. Biermann, Julia K. Becker, A. Meli, W. Rhode, E.-S. Seo and T. Stanev: Cosmic Ray Electrons and Positrons from Supernova Explosions of Massive Stars. In: Physical Review Letters, PRL 103, 061101 (2009), DOI: 10.1103/PhysRevLett.103.061101

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