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Editorial

Focus Point on evaluation of the ^{30}P proton capture reaction rate in classical novae

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The radiative capture of protons on the unstable nucleus phosphorus-30 is a potential bottleneck in the nucleosynthesis occurring during thermonuclear astrophysical explosions called classical novae. Dozens of these explosions happen in our Galaxy every year, many of which are observed astronomically. If we could quantify the rates of all of the nuclear reactions that take place during novae, we could predict the isotopes of the chemical elements synthesized and ejected into the interstellar medium for use in the formation of subsequent generations of stars and planets. In fact, we already know the rates of most of these reactions after decades of nuclear physics experiments and refinements of nuclear theory. The rate of proton capture on phosphorus-30 is an exception: it is the last piece of nuclear physics information needed to determine whether or not some microscopic grains of stardust delivered to Earth by primitive meteorites actually condensed in the outflows of nova explosions that took place billions of year ago, before the Solar System was formed. It is challenging to determine this reaction rate because there are several resonances closely spaced in energy that might contribute. Many experiments and theoretical calculations have been carried out over the past 12 years that have been devoted to discovering and characterizing these resonances, but attempting to integrate the available information is a challenging task because doing so can lead to contradictions.

In 2014, I organized and participated in a satellite workshop to the *Nuclei in the Cosmos XIV* symposium in Debrecen, Hungary, entitled *Classical Novae in the Cosmos*. Much of the workshop was devoted to discussing data on the phosphorus-30 proton capture reaction in order to find potential solutions to the apparent contradictions. I am indebted to Prof. Zsolt Fulop and the ATOMKI laboratory for offering to provide a venue for the workshop and to all of the attendees for their contributions to the lively discussion. Prof. Fulop suggested that the involved researchers have an opportunity to summarize their findings in what has become the present *Focus Point*, providing an open venue for discourse on the phosphorus-30 proton capture reaction. The contribution of Saastamoinen, Kankainen, and Trache [1] describes using the beta decay of chlorine-31 to study the nuclear structure of resonances in sulphur-31, the product of phosphorus-30 proton capture. The contribution of Parikh, Wrede, and Fry [2] attempts to reconcile the properties of these resonances as deduced from in-beam gamma-ray spectroscopy measurements and charged-particle transfer reaction measurements. The contribution of Bouhelal and Hass [3] presents theoretical nuclear shell model calculations in a broad sd-fp model space that is able to produce both even- and odd-parity states. These articles will contribute to the goal of converging on a community evaluation of the rate of proton capture on phosphorus-30 and its associated uncertainties for use in astrophysical simulations of novae.

References

1. Antti Sastamoinen, Anu Kankainen, Livius Trache, Eur. Phys. J. Plus **131**, 272 (2016).
2. A. Parikh, C. Wrede, C. Fry, Eur. Phys. J. Plus **131**, 345 (2016).
3. M. Bouhelal, F. Haas, Eur. Phys. J. Plus **131**, 226 (2016).

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Guest Editor