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Editorial: Phosphorus chemistry in the interstellar medium and planetary atmospheres

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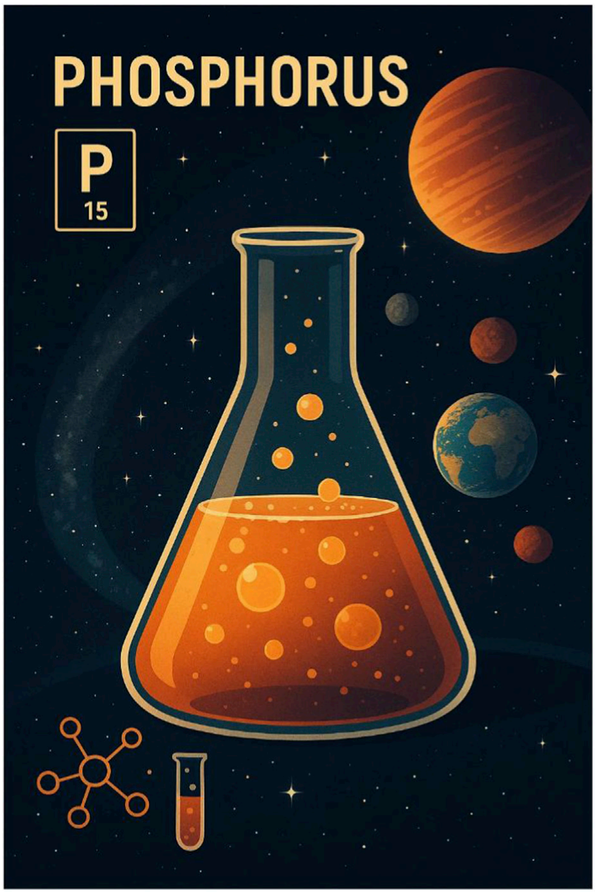
Editorial on the Research Topic
Phosphorus chemistry in the interstellar medium and planetary atmospheres

A few years ago, we were intrigued by the possibility of life on Venus (Greav et al., 2021), given the concentration of phosphorus-bearing molecules in its dense clouds. However, recent studies have cast a doubt on this possibility (Villanueva et al., 2021; Cockell et al., 2021). Still, the community recognized a knowledge gap for phosphorus chemistry in the interstellar medium, planets and their atmospheres, comets, and other objects in the Universe. Phosphorus is a pivotal element that can be used as a life-signaling element or to indicate regions that can support life in our Universe (Bains et al., 2021). Its reactivity and transformations can also aid in understanding the Earth's early stages of evolution. For these reasons, the lack of knowledge about phosphorus astrochemistry is a pressing issue.

The scientific community has started to devote time and effort to filling the information gap about the presence of phosphorus in our Universe. A search in the databases can reveal how research on phosphorus astrochemistry has progressed in recent years. *Frontiers in Astronomy and Space Sciences* decided to create a Research Topic on phosphorus chemistry entitled "*Phosphorus Chemistry in the Interstellar Medium and Planetary Atmospheres*", bringing together original papers in this field.

The current Research Topic is expected to enhance our understanding of phosphorus and P-bearing molecule chemistry in the ISM and planetary atmospheres. To suggest reaction networks that include the sources and sinks of P-bearing molecules, Fernández-Ruz et al. proposed a mechanism-reduction approach based on a parameter hierarchy necessary to model and simulate astrophysical environments.

Original research is presented by Abbatiello et al. and Chen et al., focusing on phosphorus geochemistry and gas-phase reactions, respectively. The first shows the availability of olivine and its role as a phosphorus source. The second study examined the radiative emission due to reactions of diatomic P-bearing molecules. Both can aid in the observation of molecules containing phosphorus and the modeling of astrochemical systems.



GRAPHICAL ABSTRACT

Fontani discusses the challenges of phosphorus observation and the primary techniques used for this task. Additionally, he reviews the processes involving phosphorus chemistry, including the known main carriers and the role of surface chemistry. He demonstrates that phosphorus chemistry is a multidisciplinary field, and the synergy between observation, laboratory studies, modellers, and computational chemistry is a more effective approach to tackling this problem.

Last but not least, Bains et al. present a review of Venus's phosphine. They demonstrate that phosphorus measurements in Venus' atmosphere remain an open problem, particularly regarding their sources. An open issue due to observation limitations and the lack of a more comprehensive chemistry model that incorporates gas-phase reactions, geochemistry, and aerosol chemistry. If building a chemistry model for our atmosphere is complex, imagine the complexity and knowledge required to model Venus' atmosphere. This review is an excellent motivation for future studies.

We hope that you enjoy reading these articles as much as we enjoyed collecting and editing them for you. We also aim to motivate all readers to engage in our challenge to improve knowledge of phosphorus by enhancing observational techniques, improving data analysis to address observational uncertainties, and determining the spectroscopic lines of phosphorus-bearing molecules.

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