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Physikalisches Kolloquium

Title: **Precision spectroscopy of the simplest molecule: a novel approach to fundamental physics topics**

Speaker: **Prof. Ph.D. Stephan Schiller, Heinrich-Heine-Universität Düsseldorf**

Date & time: **Friday 23.05.2025, 2 pm**

Location: **ZKS-Uhrturmhörsaal, S2|08, R. 171, Hochschulstraße 4**

Host: **Prof. Dr. Wilfried Nörtershäuser**

Abstract:

This colloquium will focus on a system having a nearly 100-year-old history in quantum physics. At the end of 1926, the same year that Schrödinger presented his wave equation, it was applied for the first time to a molecule, the molecular hydrogen ion H_2^+ [1].

Even famous physicists such as Pauli, Teller, Herzberg, Dehmelt, Lamb worked on this and related molecules at some time. Nevertheless, for the first 70 years, it did not appear that this family of three-body systems (H_2^+, HD^+,…) would become of much relevance to fundamental physics - it was too difficult to handle, experimentally and computationally. Interest focused on other, in part simpler systems, such as the hydrogen atom, the helium atom, as well as exotic hydrogen-like and helium-like systems.

However, thanks to the devoted efforts of a few theorists and experimentalists, today the precision physics of the molecular hydrogen ions is entering center stage [2]. Their study now begins to contribute to the determination of fundamental constants, tests of quantum physics, and the search for beyond-Standard-Model interparticle forces [3].

Furthermore, the perspective of comparing vibrational transitions in H_2^+ [4] and its antimatter counterpart composed of two antiprotons and one positron could lead to novel and ultra-accurate tests of CPT invariance [5,6].

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[2] S. Schiller, Contemporary Physics 63, 247 (2022)
[3] S. Alighanbari et al., Nature 581, 152 (2020); S. Patra et al., Science 369, 1238 (2020); I.V. Kortunov et al., Nat. Phys. 17, 569 (2021); M. Germann et al., Phys. Rev. Res. 3, L022028 (2021);
S. Alighanbari et al., Nat. Phys. 19, 1263 (2023); S. Schiller and J.-Ph. Karr, Phys. Rev. A 109, 042825 (2024);
[4] M.R. Schenkel, S. Alighanbari, S. Schiller, Nature Physics 20, 383 (2024), and subm.
[5] H. Dehmelt, Physica Scripta, T59, 423 (1995); E.G. Myers, Phys. Rev. A 98, 010101 (2018)
[6] C. König et al., Phys. Rev. Lett. to appear (2025)