New Mystery of Deuteron radius

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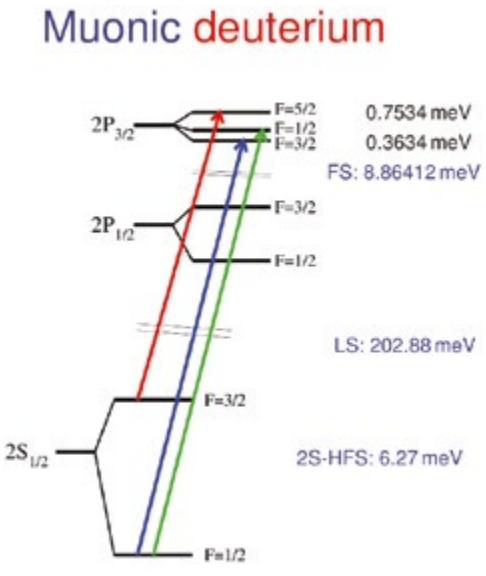
In agreement with previous results obtained for the proton radius and published by the team in Nature in 2010 and in Science in 2013, new results published in Science 2016 prove that the deuteron radius is also smaller than previously established.

Deuteron, the nucleus of the deuterium atom, is composed by one proton and one neutron, being the second simplest nucleus, just after the hydrogen nucleus, the proton. Deuteron radius is an important property for the understanding of the nuclear forces and its structure. These new results were obtained by measuring three 2S-2P transitions, in muonic deuterium (the exotic atom formed by a deuteron and a negative muon instead of an electron). They lead to a deuteron radius value r(d) = 2.12562(78) fm, which is 2.7 times more accurate but 7.5σ smaller than the CODATA-2010 value r(d) = 2.1424(21) fm. Also, r(d) is 3.5σ smaller than in its electronic deuterium form. The assessment of the proton radius, by using the values obtained from muonic deuterium [3], results in a similar value to the one obtained in the former publications using muonic hydrogen, reinforcing the so called "proton radius puzzle".

This achievement was only possible at Paul Scherrer Institute (PSI), near Zurich (Switzerland), where the most intense proton beam in the world exists, capable of generating the required muon beam for the production of muonic hydrogen and deuterium. This work was performed by a multidisciplinary collaboration of 33 researchers from different countries in which each team has brought its own expertise in the fields of accelerator physics, atomic physics, laser technologies and detectors. The Portuguese team, which includes I3N-Aveiro researchers (João Veloso and Daniel Covita), had a crucial contribution in the development of the X-ray detector system needed to achieve the successful experimental measurement.



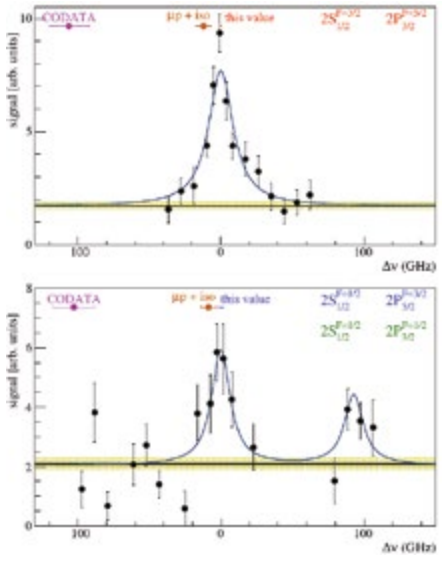


FIGURE 1
n = 2 levels in muonic deuterium. The three measured transitions are indicated.

FIGURE 2
Three measured resonances in muonic deuterium.