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New application of a Sona transition unit: Observation of direct transitions between quantum states with energy differences of 10 neV and below

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For more than 50 years Sona transition units have been used at polarized sources to exchange the occupation numbers between 'pure'hyperfine substates. For instance, hydrogen atoms in the hyperfine substate $|F = 1,\, m_F = +1\rangle$ are transferred into $|F = 1,\, m_F = -1\rangle$ when these atoms are passing a static magnetic field gradient between two opposing solenoidal magnetic fields. Thus, the magnetic field direction, i.e. the quantization axis, is rotated faster than the spin orientation can follow due to the Larmor precession.
In parallel, the atoms traveling through the zero crossing of the static magnetic field experience in their rest frame an oscillating magnetic field. This oscillation is equivalent to an external radio frequency field of frequency $f = v_{atom}/\lambda$ that can induce transitions between hyperfine substates with the energy difference $\Delta E = h \cdot n \cdot f$, where n is an integer. Here, the distance between the opposite coils determines the wavelength λ, thus the beam velocity v_{atom} can be used to manipulate the frequency f to induce transitions between quantum states with energy differences of 10 neV and below. These tiny energy differences can be found between hyperfine substates of hydrogen atoms at low magnetic fields in the Breit-Rabi diagram. In this talk first measurements, their interpretation and possible applications will be presented.

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