ACCURATE PREDICTION OF CLOCK TRANSITIONS IN A HIGHLY CHARGED ION WITH COMPLEX ELECTRONIC STRUCTURE

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It was recently shown that coupling of ultralight scalar dark matter to the standard model leads to oscillations of fundamental constants and, therefore, may be observed in clock-comparison experiments. Highly charged ions such as Ir^{17+} allow for the development of novel atomic clocks with high sensitivity to the variation of the fine-structure constant and, therefore, dark matter searches. The clock transitions are weak and very difficult to identity without accurate theoretical predictions. In the case of Ir^{17+}, even stronger electric-dipole (E1) transitions eluded observations despite years of effort raising the possibility that theory predictions are grossly wrong. In this work, we have developed a broadly-applicable approach that drastically increases the ability to accurately predict properties of complex atoms and applied it to Ir^{17+} providing accurate predictions of transition wavelengths and E1 transition rates. Our results explain the lack of observation of the E1 transitions and provide a pathway towards detection of clock transitions. Computational advances demonstrated in this work are widely applicable to most elements in the periodic table and will allow to solve numerous problems in atomic physics, astrophysics, and plasma physics. We are currently developing an online portal with access to a database of high-precision atomic properties and a package of atomic codes that can be used to compute these properties.