Towards a 148 nm CW Laser for ^{229}Th Nuclear Clock Operation

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Laser spectroscopy of the metastable nuclear excited state of ^{229}Th with an excitation energy of 8.35 eV (148.38 nm) has been achieved in 2024 for the first time by three research groups [1-3], thereby paving the way for the development of a nuclear optical clock. The laser technologies used in these measurements are pulsed four-wave mixing in Xe-gas [1,2] as well as direct fre-quency comb spectroscopy [3]. For the development of a nuclear optical clock it would be ideal, if a continuous wave (cw) laser at the required vacuum ultra-violet (VUV) wavelength of 148.28 nm was available. However, this wavelength poses a challenge and no such cw laser is currently available.

Within the frame of the NuQuant project we tackle this issue and plan to develop a cw laser at 148.38 nm. Technologically, we are investigating the material $BaMgF_4$ for second harmonic generation (SHG) as suggested in [4]. The material is nonlinear and transparent at 148.38 nm. Further, it is ferroelectric and allows for quasi phase matching (QPM) via periodic poling (PP) as has already been demonstrated at larger wavelengths [5]. The technological challenge is to achieve sufficiently small poling periods to permit QPM in this particular material. Work is currently underway in collaboration with the Leibniz Institute for Crystal Growth (IKZ) in Berlin, the Fraunhofer Institute for Physical Measuring Techniques (IPM) in Freiburg as well as the Leibniz University of Hannover. A report on the most recent status of the project will be given.

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