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Detecting dark matter with atomic systems

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The mystery of dark matter (DM) is a long-standing issue in physics, with numerous dedicated experiments returning no confirmed detections. As many direct detection experiments rely on catching a signal of nuclear recoil, these types of experiments are not applicable to many DM models.

Instead, we can utilise the precision that atomic physics allows to search for potential interactions between atomic systems and DM, with possibilities spanning a large mass range. If we have a DM particle with masses just above electrons, then we can search for signals of atomic ionisation. If we move to masses just below electrons, then we look to absorption of DM on atomic electrons.

Moving much further down to where DM begins to behave like a classical field, then we can measure the effects with atomic systems, such as those in atomic clocks and variations in fundamental constants. Additionally, interactions such as these many be possible to detect with current and
upcoming detection experiments.

In this work, I will discuss the prospect for DM detection with atomic systems, the tools needed to accurately assess the possibility, and potential implications for experimental searches.

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