

Summary: The nature of dark matter is currently unknown, and many possibilities regarding its particle character are currently being studied and searched for. One such hypothetical possibility is atomic dark matter, whereby there are at least two (and possibly more) dark matter particle species (say a dark electron and a dark proton) which interact with each other via their own form of "dark electromagnetism". This may lead to the formation of "mirror stars" in our galaxy, basically invisible stars made of collapsed dark matter that radiate dark photons instead of regular photons, and which may or may not produce energy through internal processes in their cores, analogous to regular stars. If this hypothesis for dark matter is correct, then mirror star formation is highly likely, and furthermore it is likely that these mirror stars capture a small amount of regular matter from the interstellar medium (think gas and dust) in their cores, which are heated up and produce optical and X-ray signals (see <https://arxiv.org/abs/1909.04071>). These signals would be faint but very distinctive and could be searched for in telescope surveys, but a careful calculation of the heating and cooling of the captured interstellar gas is required. This undergraduate project would involve one or two undergrads who would first study the atomic physics of interstellar gas clouds, such as their heating and cooling mechanisms, from advanced astrophysics textbooks under the supervision of Profs Matzner and Curtin, which may take a semester or two. Following this foundation, the students would collaborate to compute the heating and cooling rates of the gas captured by mirror stars, solve for its structure in the gravitational well of the mirror star, and produce predictions for its electromagnetic flux and the emission spectrum, which can then be used to search for mirror stars in telescope surveys. It is expected that this research will yield at least one published paper, as well as considerable expertise and training in astrophysics with connection to high energy particle physics.