The focus of my project is to answer if sub-dwarf OB or white dwarf stars of ~10^4 Kelvin can cause gas clouds to emit emission line ratios matching those found in Low Ionization (Nuclear) Emission Regions (LI(N)ERS). We do not yet have all of our results, but they will be provided in the form of BPT Diagrams, which represent a ratio of ratios, OIII to Hβ, to NII to Hα. Different regions of the BPT Diagram are associated with different galaxy types, including LI(N)ERs, so these diagrams will reveal the answer to our question.

To execute this investigation we use a photoionization model known as Cloudy, which accepts inputs of spectral energy distributions (SEDs) that model the radiation of different stars, and gas clouds with different properties and then outputs a wealth of data including emission and absorption line strengths. Cloudy is based on radiative transfer equations, which are very complex and take many forms. These equations take into account many higher-level quantum mechanical and thermodynamic processes and ultimately describe how heat moves through a cloud of gas, ionizing it and radiating it away. This allows calculation of different emission line strengths and other properties of the gas cloud based on input radiation. The bulk of the mathematical content of this project will focus on these equations, as it provides an understanding of our main tool in our research using advanced undergraduate physics topics.

I will be using a project proposal paper written by Dr. Dhanesh Krishnarao (Dr. DK) that describes our larger scientific project that this project is a piece of to provide context and significance of this project. I also have a preprint copy of a paper describing methods of photoionization simulation in galactic structures by some of Dr. DK's collaborators that will be useful in connecting the radiative transfer equations to larger-scale modeling. The textbook Physics of the Interstellar and Intergalactic Medium by Bruce Draine will provide the majority of the information regarding radiative transfer. I intend to search for some other papers potentially adding more background to the search for the radiation source of LI(N)ER-type galaxies and potentially already-published papers of photoionization modeling.

The results of this project may not be particularly interesting to non-astrophysicists, but the results are intended to allow more research into our own Milky Way galaxy, helping us better understand our place in the universe, and could potentially be useful in discerning the process of galactic evolution, and thus the origin of our existence. Using the results of our project, we intend to develop a stellar population that models the central Milky Way. This would provide insight into the type of stars in the center of our galaxy, its structure, and would provide tools to do future research in our galaxy and in other LI(N)ER-type galaxies.

While radiative transfer becomes formidably complex, it is ultimately based on ionization and other quantum-mechanical topics that are introduced in Introductory Modern Physics. While I have a basic understanding of some higher level extensions of these concepts, working on this project along with my future classes in relativistic and non-relativistic quantum mechanics and thermal physics will allow me to better grasp these concepts and their applications in galactic astrophysics. It also expands on my previous course in extragalactic astronomy, and will fit in well with the courses in astrophysics and observational astronomy I am taking later this year. I plan to go to graduate school and pursue a PhD, and practicing communicating and contextualizing my research will have massive payoffs in sharing my future research, communicating physics concepts for the purpose of education, and collecting resources to create a starting point for future projects, all things that will be important in grad school and in a future career in physics.

I don’t anticipate an extreme variability between the intensiveness of classes. I believe they will all be hard and take a lot of time. I plan to follow the schedule given in the calendar of our binders to pace myself and to keep myself on track. I hope to be very familiar with my resources and the math of my topic by the end of this block so that I don’t have to learn too much extra in the following courses.