Dissertation Abstract


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Background:

The plane of the Milky Way galaxy contains most of the stars of the galaxy, and most of the dust and gas in the galaxy. This dust obscures the view of the galaxy in visible light. As a result, the plane of the galaxy is relatively poorly studied. In this dissertation study, a random sample of stars centered on galactic longitude 30° within 2° of the plane of the galaxy is studied in infrared wavelengths. Dust that obscures visible light is transparent in the infrared, so the stars are easily visible. Infrared spectra are obtained for twenty objects. This data is compared to existing observations when available, and is modeled to determine the nature of the objects populating the plane of the galaxy.

Abstract:

Intermediate resolution ($\Delta \lambda/\lambda \geq 20$) infrared (2.9 - 13.5 μm) spectra were obtained for a random, flux-limited sample of sources in the galactic plane (|b| < 2°). The spectra fall into four distinct groups: those with strong [NeII] emission, with weak 10-11 μm features, with broad long-wavelength emission, and with deep silicate absorption. The IRAS [12]-[25] and [25]-[60] colors of the sources show that objects of each spectral group lie near each other in distinct regions of the color-color plane. A large fraction of these sources (40%) show silicate absorption which are among the deepest measured. The sample is shown to be made up of HII regions and embedded B stars, and evolved stars with circumstellar shells which range from optically thin to extremely thick. Three new carbon stars are identified, and one star with what appears to be silicate absorption superposed on silicon carbide emission is presented. Two stars show diffuse shells and emission features centered on 10.5 μm which are broader than simple silicate or silicon carbide emission features. Distances and luminosities are derived for all objects, and simple evolutionary scenarios are presented. The spectra are shown to be in agreement with models of late stellar evolution, although some extensions to redder colors and higher mass-loss rates are required.

Impact on Teaching:

My dissertation impacts the content I teach only to a minor extent. In Descriptive Astronomy, I am probably more likely to emphasize the importance of spectra, and the importance of multi-wavelength observations, more than I would have before my doctoral program. Where my dissertation work more directly affects my teaching is in the perspective I try to put forward about what science is and how it is done. Before my graduate studies, I was more likely to emphasize the theoretical underpinnings to science, the equations and so on. My graduate work was highly observational, and it taught me the importance of observation and a feeling for what it means to carefully take data. My graduate work also
taught me the importance of the step between observation and theory, that of data
calibration and reduction. This is the step that consumes the majority of the time in many
observational or experimental projects, but it is not at all glamorous (or in fact, interesting in
any way to one outside the project). Because of my graduate work, I am much more likely
to emphasize at least basic calibration and error analysis to my undergraduate students in
laboratory experiences.

My graduate research in astronomical imaging and image restoration instilled a keen interest
in these topics. As a result I developed an independent study course in Astronomical
Imaging using the Osten Observatory that I taught to two students in the spring of 2008. I
have also spent a great deal of time taking images at the telescope and enhancing them in
my office, to use to publicize the observatory and to teach students how images are made.

My graduate work in total, including not just my dissertation work but also my coursework
and other projects I worked on in graduate school, have affected my teaching in other ways
too. I learned through my graduate courses that I am much better at highly abstract and
mathematical topics like quantum mechanics and electricity and magnetism, than I ever
would have imagined as an undergraduate. This results in my being much more comfortable
in teaching courses like Classical Mechanics or Electricity and Magnetism, than a course like
Electronics. Knowing that, it helps me focus on my deficiencies when that course comes up
in the rotation.

My research assistantship in graduate school involved vast amounts of programming for data
reduction of large data sets. I learned through this that I have some interest and ability in
programming. As a result of that, I have tried to put a bit more numerical simulations into
my courses. I have also been working to incorporate some actual programming into some of
my courses, although that is a work in progress, as I assess the best tool to use, and then to
learn it myself. But my graduate work strongly influences both my interest in this, and the
directions I see this idea going.