Polarization of circumstellar bow shocks due to electron scattering
Manisha Shrestha\textsuperscript{1}, Jennifer L. Hoffman\textsuperscript{1}, Hilding R. Neilson\textsuperscript{2}, Richard Ignace\textsuperscript{2}
\textsuperscript{1} University of Denver, \textsuperscript{2} East Tennessee State University

Motivation
Circumstellar material (CSM) probes stellar mass loss and provides a link between progenitors and interacting supernovae.

- Bow shocks are common CSM configurations.

\begin{itemize}
  \item Since a bow shock projects an asymmetrical shape onto the sky, light from the star should become polarized by scattering from free electrons in the shock region.
  \item We investigate the polarization signatures produced by this effect.
\end{itemize}

Introduction
A bow shock forms when a star moving more quickly than the speed of sound in the local interstellar medium emits a stellar wind that drives a shock wave into the ISM.

- The shock region has a high density of ionized gas that can polarize light via electron scattering.
- Bow shocks may be detectable with polarimetric observations even if the system is unresolved.
- These polarization signatures can constrain stellar wind speeds, stellar motions, and ISM properties in faraway systems. They may also be identifiable in interacting supernovae, helping to connect them with massive progenitors.

Methods
We use Monte Carlo based radiative transfer code \textit{SLIP} to do simulations of our model. \textit{SLIP} is based on the method of Whitney\textsuperscript{2} (2011, BASI, 39, 101). It tracks photons from a central source as they scatter and become polarized in a user-defined CSM region.

- In this code we can vary different parameters of CSM such as temperature, shape, optical depth, viewing angle.
- We are trying to make the thickness of one grid shell for CSM.

Results

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
\textbf{Viewing Angle} & \textbf{Color Bar} & \textbf{0°} & \textbf{17%} & \textbf{33%} & \textbf{50%} & \textbf{67%} & \textbf{83%} & \textbf{100%} \\
\hline
\textbf{θ=0°} & & & & & & & & \\
\hline
\textbf{θ=45°} & & & & & & & & \\
\hline
\textbf{θ=90°} & & & & & & & & \\
\hline
\textbf{θ=120°} & & & & & & & & \\
\hline
\end{tabular}
\caption{Comparison of polarization maps for different viewing angles and temperature with other parameters constant}
\end{table}

\begin{itemize}
  \item Pattern of percentage polarization changes as we change viewing angle, so imaging polarization could help constrain a bow shock's orientation.
  \item %P and %Q decreases or increases with temperature depending on viewing angle. The sign of %Q could be used to constrain orientation in the unresolved case.
  \item Polarization increases towards the edge of the bow shock, probably due to edge effects in the model.
\end{itemize}

Discussion and Conclusion

\begin{itemize}
  \item We plan to compare polarization of bow shock with other CSM geometries.
  \item We will experiment with a gradual density decrease instead of a sharp cut off, to minimize edge effects.
  \item We plan to do dust polarization using \textit{SLIP} and compare with Neilson's model.
\end{itemize}

Future Work

Acknowledgments
This research has been supported by the National Science Foundation (AST-1210372 to Jennifer Hoffman), and University of Denver.

\textbf{mshrest9@du.edu}