Physics 224: Paper Discussion 1
Winter 2020

Redfield & Linsky 2008:

- The text states that there are two main sources of error taken into account when predicting CII column density from SII: the propagated error in N(SII) and errors in solar abundances of sulfur and carbon. How significant is the error associated with the fact that the ionization potentials for CII and SII, while very close, are actually different?
- I get that the general premise of the paper is to look at the local interstellar cloud (LIC) and identify within it individual clouds by looking at velocity profiles. To do this, the authors are looking at Ca II lines and not Na I because they are looking at tracers of warm gas instead of cool gas. I am unclear about two questions, unrelated. One, the paper mentions that the Na I lines are closely associated with Ca II lines in clouds, i.e. the "cold gas detected by the Na I emission is physically associated with the warm gas detected by the Ca II absorption" (pg 285, para 1 in the left column). If that is the case, then what does that say about identifying clouds on the basis of velocity profiles if these clouds are physically mixtures of cold and warm gas? Secondly, and this is more basic and out of curiosity, both these lines are part of the Fraunhofer lines, observed in the solar spectrum. I am not sure whether these would be present in some measure in the UV stars. However, my question is more basic - If present, how do we differentiate the absorption lines from a stellar atmosphere from the same absorption lines in the ISM?
- Given the proposed connection with Radio Scintillation Screens, can the results of this paper be used to predict line-of-sight paths to (as yet unobserved) radio objects that would experience scintilation from these screens? If so can the magnitude of the scintillations be predicited as well.
- This question is regarding figure 18 and section 4.2, where they create a couple models of the warm LISM based on data indicating 1.7 absorbers per sightline. I'm unclear why these models are useful, because the data do not fit either of them well at all. I understand that the data is biased against smaller clouds, and they say some numbers relating to surface area and unassociated velocity components agree between the data and the simulations. But it's not clear to me that anything useful can be drawn from 15 data points that diverge as strongly from the simulations as figure 18 shows.
- The authors suggest that heliosphere is located at the transition between the LIC and G cloud. Why are there no absorption features in the stellar spectra

as there were in Zachary et al 2018?

- The morphology of clouds seems especially important for discussing interactions between different clouds, as identified by the survey presented in the paper. How come the assumption can be made that HI is constant throughout a given cloud? If this assumption is relaxed, like the paper mentions, it would seem that the morphology of the clouds can vary greatly, since the edge of the cloud would be much more poorly defined. Following this line of thought, how come we can make the conclusion that a substantial number of the identified clouds in the survey have filamentary structures? How would relaxing this requirement on the edge of a cloud affect the fitting procedure for identifying clouds? What would be a reasonable way to test this assumption? In some ways, it seems arbitrary since the definition of a cloud seems fairly vague, but maybe that's just my own unfamiliarity with the terminology. Could you get a start by doing a targeted survey on the cloud edges, with finer sampling of these regions, especially for two nearby clouds and the region between them?

- They talk about 3 clouds, NGP, Oph, and Cet which don't obey their rigid velocity fit but they believe to be single clouds do to how compact they are, and I'm unsure of how you can tell they are compact in three dimensions, even with multiple sight lines if they are a far enough distance away and aren't multiple clouds stacked along your line of sight.

- Is it possible to improve the cloud identification in the paper by exploiting the dust-gas coupling in the ISM and measuring the polarization direction of the sample stars?

- I wonder if cloud-cloud collisions are important for only the local ISM or the ISM everywhere. Do they happen more frequently in local ISM?

- The two instruments used were STIS and GHRS onboard HST. The cutoff wavelength of GHRS is about 115nm and some of the observations were close to the cutoff. Could instrumental limitations have led to a decreased number of identified cII and cII* sight lines? Also, how would better measurements of SII further constrain the electron density?

- I wasn't entirely clear on the scope of the simulations discussed in section 4.2 (Volume Filling Factor of the Warm LISM). Are they essentially just randomly orienting clouds and seeing which situations correspond to our observations?

- Why is the temperature of the LIC so high?

Zachary et al. 2018:

- In section 5, the authors predict properties of the environments that Voyager 1 and 2 will encounter over the next hundreds/thousands of years. What can be done with this information if the Voyager mission is near the end of its lifetime?
- This question relates to my question for the first paper (Redfield and Linsky). So we managed to decouple the absorption from the detected atmosphere around GJ 780. This was based on developing models for the heliosphere. This star and ISM studied are all in a local environment (Close to Earth). So the question is whether this modelling (presumably for an individual star) can be implemented over a region to take into account the absorption from the stellar atmospheres, by including some form of population data of stellar types, when looking at distant ISM, say in the LMC or the SMC? Or is stellar atmospheric absorption not a significant enough contributor when the distances become large and we are looking at these integrated columns which are on distance scales comparable to the sizes of galaxies? The reason I am asking this question is because I am trying to understand if it is possible to look at these features when looking at distant galaxies and decouple these contributions through some modelling if what we are looking at is just integrated along the entire galaxy?
- The authors mention that the sight lines along which they took spectral measurements were "close" to the paths of the Voyager space crafts. I didn't see where they justified what they mean by close. The authors mention that the ISM is turbulent and dynamic. What are the length and time scales associated with the LISM in the volumes near the Voyager crafts that could justify their comparison of in-situ measurements against the line-of-sight measurements?
- Given the last decade of interstellar measurements from Voyager 1 as well as recent accomplishments in the ISM physics, what modifications, if any, would a hypothetical Voyager 3 benefit from as a probe of the interstellar medium?
- The paper projects that Voyager will travel through the LIC and might enter the Oph and NGP clouds. Can measurements of dust grains and electron density tell us things about the local structure of the LISM clouds that we can't learn from line of sight measurements like those described in the Redfield and Linksky (2008) paper? How useful is this in targeting future surveys of LISM clouds and structures?
- Each sight line was paired with two targets, three of them being M dwarfs and one being a G type star. Would the measurement from the G type star differ significantly from the M dwarf? Also, is two stars per sight line sufficient to identify small scale structure? Also also, what instruments were used on Voyager and what were their capabilities/limitations?

- When discussing heliospheric absorption they say that the other targets were upwind of the hydrogen wall and didn?t show this and thought it might be due to the high HI column densities. Would it be possible to look at further nearby targets to map out the hydrogen wall and look in places of lower HI column density to see if that hydrogen wall persists past the targets they looked at? If a target further upwind of those that they looked at displayed this heliospheric absorption it would lend credence to the idea that this hydrogen wall covers all of the targets they looked at rather than starting in between them.

- It's cool to see that their observations are consistent with previous predictions. Also I found it interesting to know how LISM are detected and analyzed, like using the redward/blueward of the hydrogen absorption to distinguish between heliospheric and astrospheric detections.

- I'm unclear on the discussion of how they are measuring the dust impacts on Voyager discussed in section 5.3. Are these voltages generated on a dedicated sensor? Will they trigger on anything besides dust?

- In figure 1, why do the profiles of the absorption components sometimes differ from the convolution of the stellar emission and absorption lines? See CII in GJ 780, for example. In other words, why don't the dips in the red lines always follow the combination of the black dashed lines?

- The spectrum of GJ 780 shows absorption from the Heliosphere and the Astrosphere. The spectrum of the other targets do not exhibit either of the absorption features, despite being in the "upwind" direction. The authors explain that the column density of HI gas of these targets are high, which obscure the feature. Is this evidence for additional cloudy features in the LISM that are in addition to the previously mentioned 15?