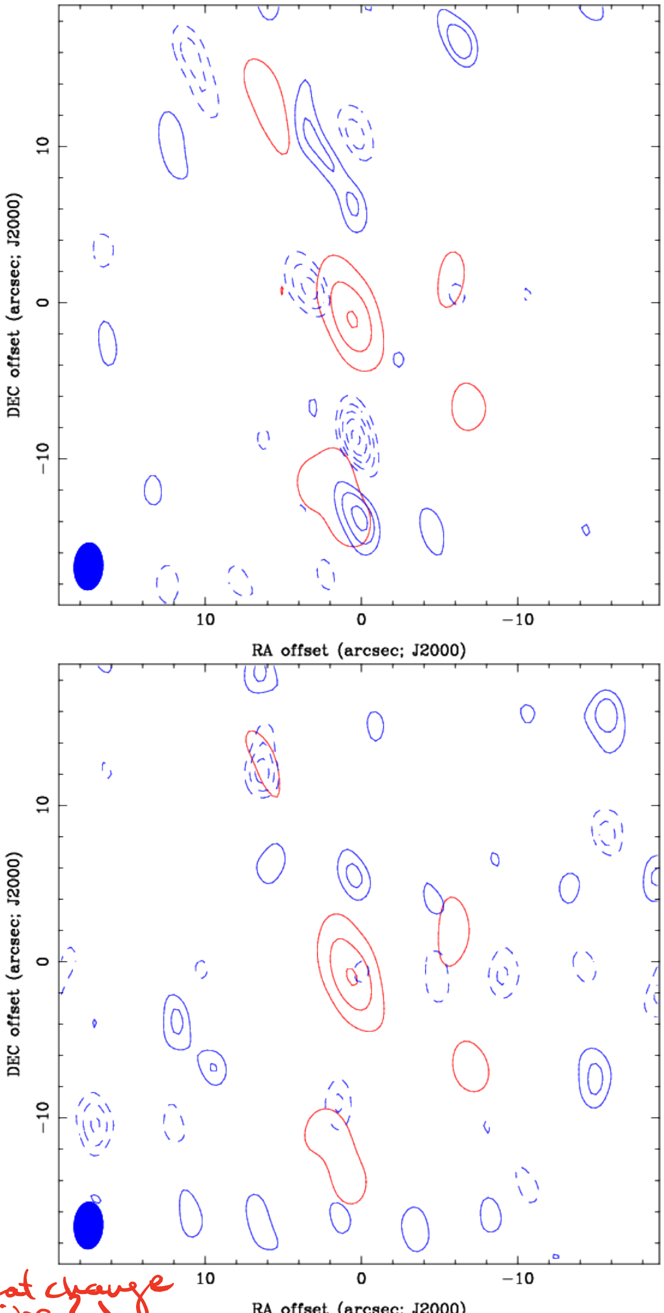
I'm not sure I understand this statement. Can you provide more explanation (or maybe I'm too jet lagged at the moment)?



Does that change anything?

Figure 1. **try getting the corrected solution with different bandpasses** Map of the continuum around 345GHz in Orion KL before (top) and after (bottom) squint correction. Red contours are Stokes I, blue contours are Stokes V. Dashed lines denote negative values, solid lines denote positive values. Note the multiple pairs of positive and negative Stokes V peaks. These largely disappear after correction. The contour scales on both maps are identical. Red Stokes I contours are at 15%, 35%, 55%, 75% and 95% of the peak intensity. Blue Stokes V contours are at -8, -7, -6, -5, -4, -3, -2, 2, 3, 4, 5, 6, 7 and 8σ levels.

In the uncorrected map.

while the SiO Stokes V signal is purely negative. Figure 5 shows the peak Stokes V signal of the SiO line. We checked the average of all the visibilities (average over all antennae baselines and all time intervals) and found that the CO Stokes V signal is more intense than the SiO Stokes V signal, and the Stokes I intensities after averaging the visibilities were approximately 50 Jy and 75 Jy for CO and SiO respectively. If the Stokes V signal were purely leakage from Stokes I then we would expect to see an SiO Stokes V signal that is stronger than the CO Stokes V signal, but we do not.

I don't see anything new paragraph

This may work better in the Discussion.

In IRC+10216 we again see Stokes V in the CO ($J = 3 \rightarrow 2$) but also ~~several signals~~ in CS ($J = 7 \rightarrow 6$), SiS ($J = 19 \rightarrow 18$), and $H^{13}CN$ ($J = 4 \rightarrow 3$). These lines and their frequencies are listed in Table 2.

I don't see anything

In NGC7538 there was a strong Stokes V detection in CH_2CO at 346.6 GHz that completely disappeared after correction. The Stokes V signal in CO ($J = 3 \rightarrow 2$) at 345.8 GHz decreased in intensity but is still ~~extremely~~ prominent.

See my comment at the top of p.7.

Finally Figure 4 shows no detection in NGC1333, with only a weak detection of CO in Stokes I.

When assessing the Stokes V detections we consult the map for obvious pairs of positive/negative peaks that would indicate beam offset and therefore a false Stokes V signal. The maps are integrated over a narrow frequency band of approximately 2 MHz so any peaks that exist should not be washed out by noise in adjacent channels. In the maps for Orion KL and IRC+10216 shown in Figure 2 there are no negative peaks around the peak of Stokes V. However in NGC7538 there is quite a large negative Stokes V peak near our chosen peak that may indicate squint. The top panel of Figure 1 shows what 'squint peaks' look like (we know these peaks are from squint because they disappear after correction) and the pairs tend to resemble each other in shape. The pair of peaks around our chosen peak in NGC7538 however have distinct shapes. The worst case here is that the signal is entirely squint but on the other hand the signal may be a mixture of real and heavily affected by squint. The detections in Orion KL and IRC+10216 are more reliable.

Repetition

Table 1 shows a summary of the objects presented and related information.

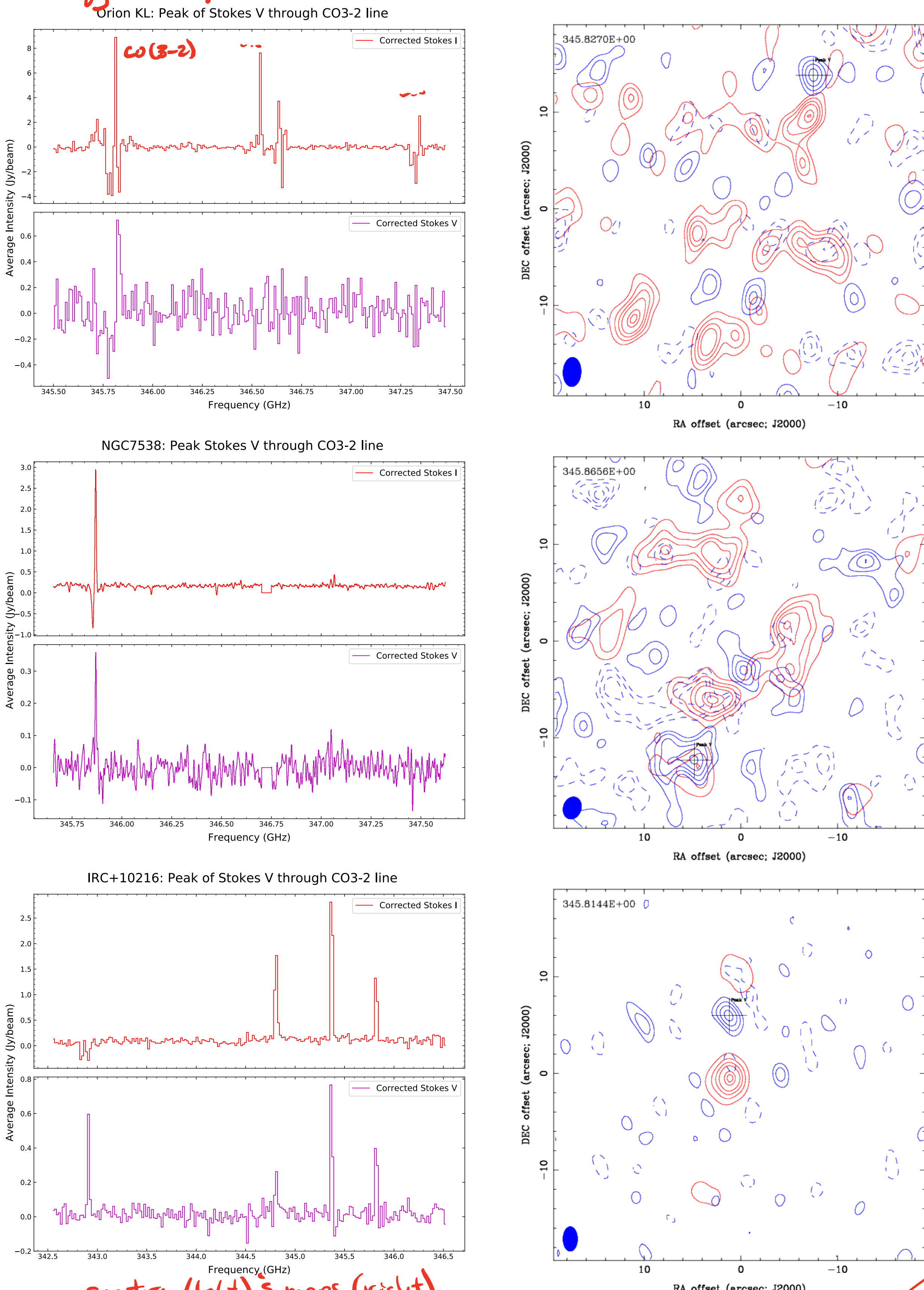
This should be right at the start of the section.

5. DISCUSSION

~~Are these detections of CP in the archival SMA data shown real or are they instrumental artifacts?~~ This is our chief concern because of the difficulty of calibrating CP measurements ~~and because the measurements~~ especially since the observations presented here were not made with any special considerations for calibrating CP as in the observation of Sgr A* reported in Muñoz et al. (2012). We will repeat here the arguments made in Section 4 ~~that these detections are~~ in support for the soundness

The first question to address is whether our CP detections are real or result from instrumental artifacts.

Can you put labels close to the lines to identify them?



spectra (left) & maps (right)

what does that mean?

Figure 2. Corrected ~~maps~~ of the CO $J = 3 \rightarrow 2$ line (345.8GHz) ~~and corrected spectra~~ for Orion KL, NGC7538, IRC+10216. ***Spectra*:** *Miriad*'s `maxfit` is used on the CO map to obtain the location on the image where the Stokes V signal at 345.8GHz is maximum, and a ~~spectra~~ spectrum is obtained through that point. The cross on the map denotes the location of that peak. The red line is Stokes I and the blue is Stokes V. The spectrum for NGC7538 is Hanning smoothed by a length of 15. ***Maps*:** Blue contours are Stokes V and are shown at the -4, -3, -2, 2, 3, 4σ levels. The RMS error for each Stokes V map is found using *Miriad*'s `imstat` command: σ =0.30, 0.15, and 0.17 Jy/beam, respectively. Dark red contours are Stokes I and the levels are 15%, 30%, 45%, 60%, 85% and 95% of the maximum. The value in the top left is the central frequency of the mapped signal and the map is integrated over a narrow bandwidth of ~2 MHz.

for Orion KL, NGC7538 and IRC+10216, respectively.

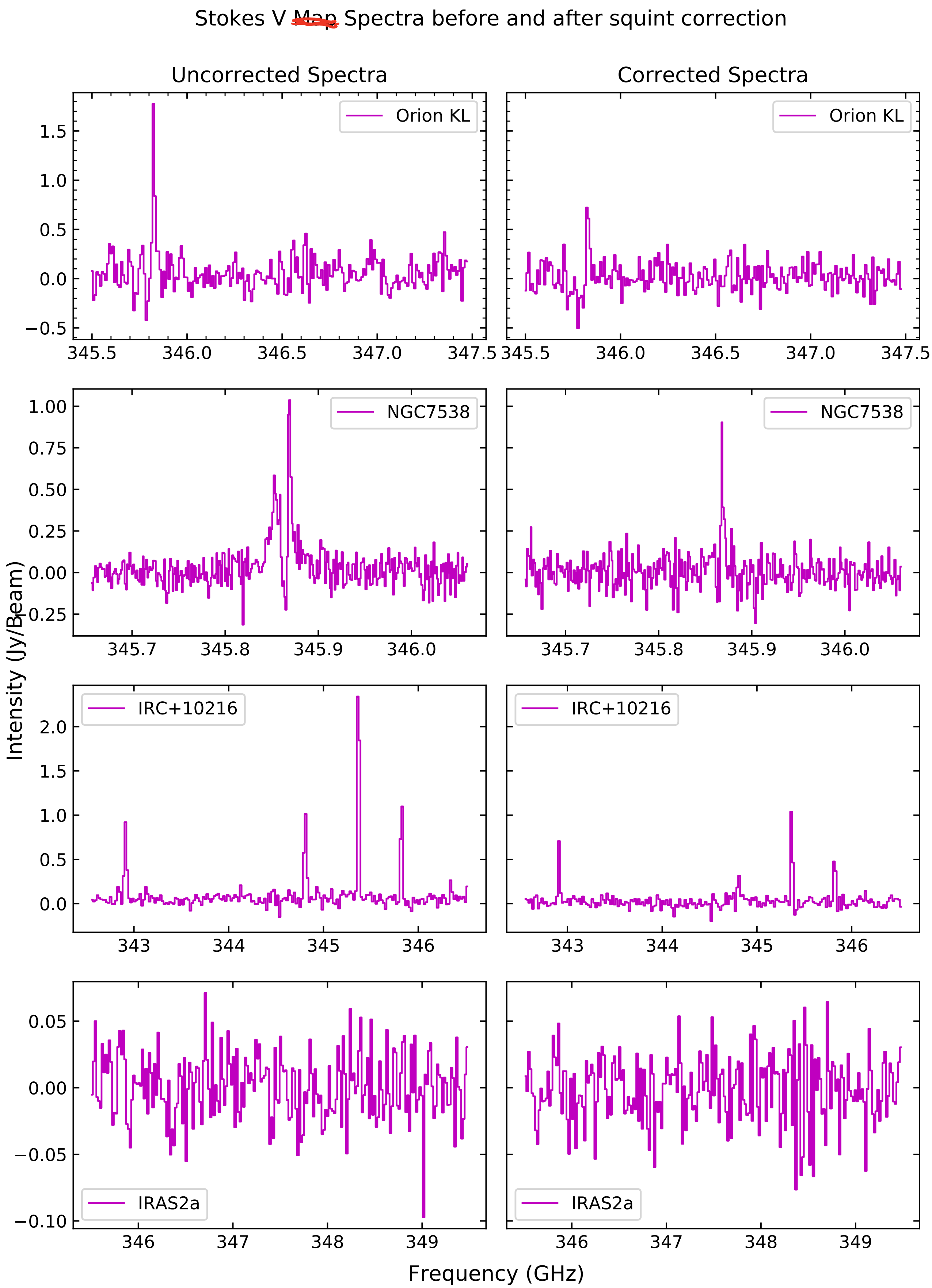


Figure 3. Stokes V spectra of all objects before and after squint correction. *Miriad*'s `maxfit` is used on the CO map for each respective object to obtain the location in the image where the Stokes V signal at 345.8GHz is maximum, and a ~~spectra~~ spectrum is obtained through that point. Note that the Stokes V signal decreases in all cases after squint correction.

This figure should go with those presented in Fig. 2. Why not split these 4 spectra-sets/maps over two successive figures (Fig. 2 ; 3)? Then the current Fig. 3 would follow (as Fig. 4), etc. For the caption of the new Fig. 3 you would write "Same as Fig. 2, but for...)".

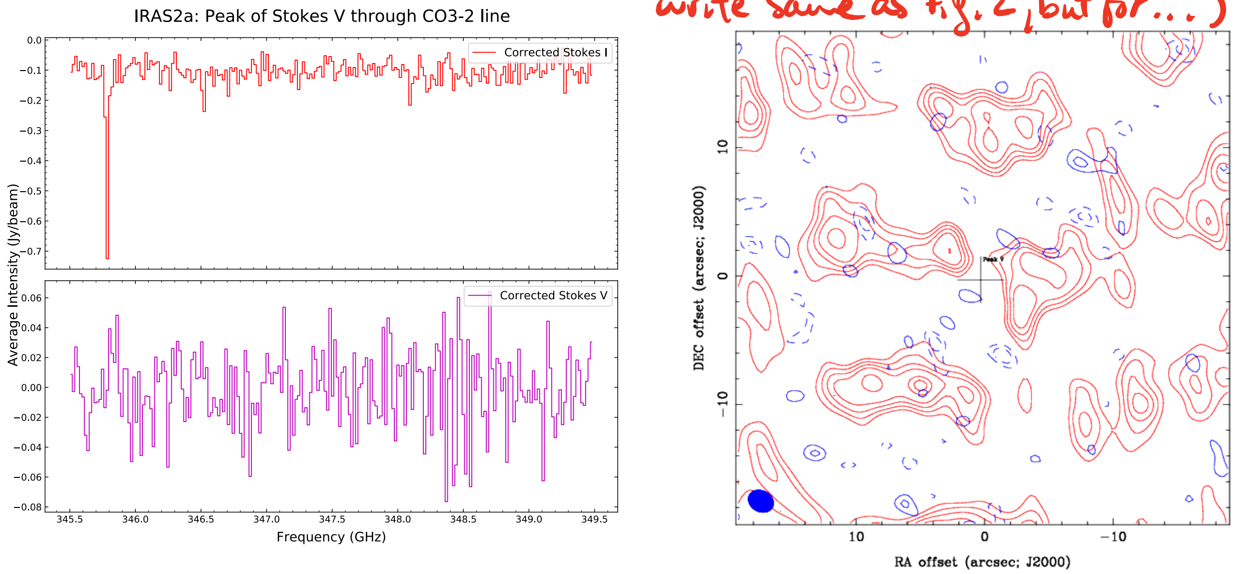


Figure 4. Corrected maps of the CO $J = 3 \rightarrow 2$ line and corrected spectrum for NGC1333 (IRAS2a). No significant Stokes V signal is detected here, probably because the object is too dim. Contours are the same levels as in Figure 2 and the spectrum is obtained the same way.

Should be discussed in Sec. 4 (early).

Object	Coordinates (J2000)	Array Configuration	Date Observed
Orion KL	RA $05^h35^m14.501^s$ Dec -05°22'30.40"	Compact	2008-01-06
NGC7538	RA $23^h13^m44.771^s$ Dec +61°26'48.85"	Compact	2014-10-28
IRC+10216	RA: $09^h47^m57.381^s$ Dec +13°16'43.70"	Compact	2009-11-24
NGC1333	RA $03^h28^m55.580^s$ Dec +31°14'37.10"	Compact	2010-10-14

Table 1. Summary of Archival Observations Used

~~real~~ of these detections. We then discuss earlier detections of CP and summarize how ARS can explain the detections presented in this work.

Firstly, we take the average of all the visibility data and note that the peak Stokes V is not proportional to the peak Stokes I at any particular frequency —a large Stokes I at 347.25GHz for example does not indicate a corresponding peak in Stokes V. This property indicates that there ~~isn't~~ is no significant leakage of Stokes I into Stokes V. This is true in Orion KL, where CO ($J = 3 \rightarrow 2$) and SiO ($J = 8 \rightarrow 7$) are the strongest lines; ~~This also seems to be true in the visibilities of~~ as well as for IRC+10216, where the Stokes I CS ($J = 7 \rightarrow 6$) and SiS ($J = 19 \rightarrow 18$) lines have similar strengths but the Stokes V at SiS ($J = 19 \rightarrow 18$) is twice as intense. However, in the same object H^{13}CN ($J = 4 \rightarrow 3$) and CO ($J = 3 \rightarrow 2$) have Stokes V intensities that appear proportional to their Stokes I intensity (stronger I means stronger V).

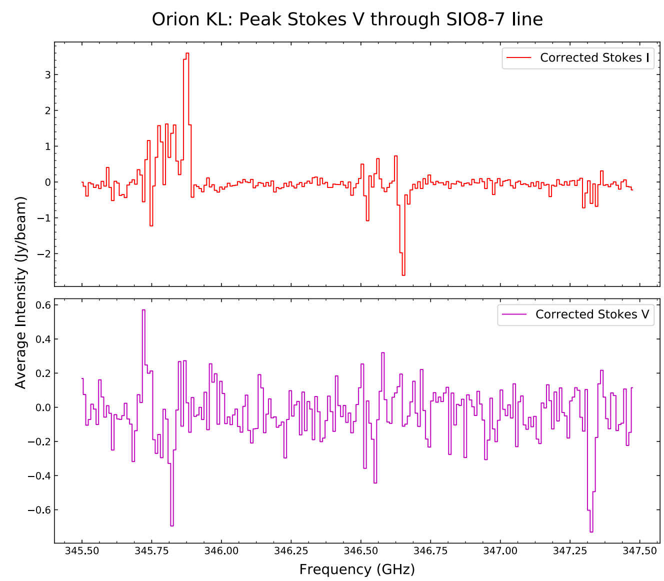


Figure 5. Peak Stokes V signal for the SiO ($J = 7 \rightarrow 8$ at 347.3 GHz) transition in Orion KL. Note there is also a strong Stokes V signal in the CO ($J = 3 \rightarrow 2$ at 345.8 GHz) transition here. The SiO signal is purely negative but the CO signal is antisymmetric.

for Orion KL why? 4

We also note that the shapes of the Stokes V signals vary across the frequency band and interpret this to mean that the signals are not instrumental in nature. For example, Figure 5 shows a spectrum ~~from Orion KL~~ for that source with Stokes V in CO and SiO. The SiO signal is purely negative (indicating only left-circular polarization) but the CO signal is antisymmetric ~~and is initially positive and then becomes negative~~, indicating the presence of both LCP and RCP. This has a physical explanation

I think this is the strongest argument but it needs to be reformulated. What you need to say is that if the CP was instrumental then it would be found at similar levels in the continuum, but this is not seen. I wouldn't bring up the fact that we believe CP to be stronger in lines, because it has been detected in the continuum at least once before.

Object	Line	(GHz)	Stokes V (Jy/beam)
Orion KL	CO ($J=3\to2$)	345.8	0.65
	SiO ($J=8\to7$)	347.3	-0.65
NGC7538	CO ($J=3\to2$)	345.8	0.85
IRC+10216	CS ($J=7\to6$)	342.88	0.6
	SiS ($J=19\to18$)	344.78	0.2
	$H^{13}CN$ ($J=4\to3$)	345.34	0.8
	CO ($J=3\to2$)	345.8	0.4
NGC1333 (IRAS2a)	CO ($J=3\to2$)	345.8	None

Table 2. Summary of corrected Stokes V signals found. The beam size is determined by the configuration of the antennae array. An intensity for the peak of the Stokes V signal is only given if the peak is noticeably higher than the noise level. The intensity quoted for CO in NGC7538 is before smoothing is applied.

I have to think about that... I'm not sure.

using the ARS model in terms of blue-shifted and red-shifted scattering populations that will be considered in Section 5.2. We know of no instrumental mechanism for producing such a signature. ~~This argument only applies to Orion KL~~. For In the other objects the Stokes V signal is always positive.

~~In the case of IRC+10216, an evolved carbon star with an extended envelope, we note that the peak of Stokes V in the CO ($J=3\to2$) map (bottom-right panel of Figure 2) is roughly 6" away from the Stokes I emission, and were concerned that the Stokes V peak was not even on the object. From single-dish CO ($J=2\to1$) observations of the shell around IRC+10216 we find the radius of the CO shell to be 50" (Fig. 1 of Cernicharo et al. 2015), indicating that the Stokes V signal is indeed on the object.~~

I don't think we need this.

Spatial filtering due to the resolution of the interferometer explains the much smaller radius of IRC+10216 in the observations presented here and also explains the frequent occurences of negative Stokes I in almost all the spectra shown in Figures 2, 4, and 5. The largest resolvable object by an interferomter is determined by the length of the shortest baseline, meaning that large scale emission can be invisible to the interferometer. For example in Orion KL the CO ($J=3\to2$) Stokes I emission is large and extended. If then the Stokes V signal comes from smaller more localized areas, we would observe peaks of Stokes V as shown and only a portion of the Stokes I that is present. The rest of the Stokes I signal would be filtered away which could shift the zero-level to smaller values. Fluctuations in Stokes I would then appear to have negative values. ***details, maybe on equation***

Finally we checked and confirmed that there were no Stokes V signals in the continuum larger than those found at molecular lines like CO and SiO. Finding a large signal in the continuum could indicate the data is suffering from instrumental artifacts since we only expect conversion of linear to circular polarization at the frequencies of molecular transitions. This is not the case: we only find Stokes V peaks at frequencies that correspond with emission from molecular lines and there is no significant CP in the continuum.

We therefore feel confident that ~~For these reasons we believe~~ the CP reported here although perhaps suffering from some level of instrumental contamination it is ~~while quite probably contaminated with instrumental effects are~~ real and originate from each of these objects. It is thus important to ~~develop the instrumentation and~~ improve the measurement and calibration of CP for future studies of magnetic fields using polarimetry.

5.1. *Earlier Detections*

Circular polarization in a molecular spectral line ~~of a Zeeman insensitive molecule~~ weakly sensitive to the Zeeman effect was first reported in Houde et al. (2013) where roughly 2% CP was detected in the ^{12}CO ($J=2\to1$) ~~line~~ transition at 230.5 GHz in Orion KL using the FSPPol at the CSO. The CP signal was ~~positive and~~ approximately symmetric ("∩"-shaped) i.e.. The observation was repeated three months after the first measurement to confirm the result ~~wasn't~~ was not spurious, with similar results. Additionally the strong line of HCN ($J=3\to2$) at 265.9 GHz in Orion KL was measured and no CP higher than the 0.1% level was detected. The detection in CO and the absence of a detection in HCN indicates that the ~~CSO~~ FSPPol/CSO observations were not suffering from leakage into Stokes V and highlights the CO molecule as a source of non-Zeeman CP. In all the objects presented here we find CP in ^{12}CO ($J=3\to2$) at 345.8 GHz (except for in NGC1333 where the CO line is weak). This is consistent with the original 2013 detection.

In follow up work Hezareh et al. (2013) examined the supernova remnant IC 443 using dust polarimetry with PolKa at APEX and polarization maps of ^{12}CO ($J=2\to1$) and ($J=1\to0$) taken with the IRAM 30m telescope. They found that initially the linear polarization maps of dust and CO differed greatly in their polarization angles. Expecting that there was conversion of linear to circular polarization due to ARS, the CO Stokes V ~~flux was~~ fluxes were then reinserted into the CO ~~Stokes U flux~~ LP signals. The resulting CO ~~map's~~ maps then polarization angles ~~now~~ agreed very well ~~with the polarization angles in~~ with each other as well as with the dust map (Fig. 9 of Hezareh et al. 2013). This result ~~gives~~ clearly establishes ~~strong support for~~ a conversion from linear to circular polarization.

5.2. *Anisotropic Resonant Scattering*

I think this would be great in the more complete Introduction of your thesis, but I'm not sure we need it in the paper.

ASE ~~Anisotropic resonant scattering~~ was the mechanism first proposed by Houde et al. (2013) to explain the presence of CP in the transitions of CO, but failed to explain the observed positive and symmetric "∩"-shaped Stokes V profile. In a follow up paper Houde (2014) considered observations of Stokes V in SiO masers and showed that different profile shapes easily arose if there were populations of scattering foreground molecules slightly outside of the velocity range of the line. For example in that case a blue-shifted scattering population of molecules results in a negative "∪"-shaped profile and a red-shifted population results in a positive "∩"-shaped profile. The presence of both a blue- and red-shifted population results in an antisymmetric "S"-shaped profile like the one seen in the top left panel of Figure 2.

The basic principle of ARS can be illustrated by considering linearly polarized radiation oriented at some angle θ to the foreground magnetic field. The incident and scattered radiation can be written in terms of the n-photon states as (Houde et al. 2013)

$$
\begin{aligned}
|\psi\rangle &= \alpha|n_{||}\rangle + \beta|n_{\perp}\rangle \\
|\psi'\rangle &\simeq \alpha e^{i\phi}|n_{||}\rangle + \beta|n_{\perp}\rangle ,
\end{aligned}
$$

-numbers

where $\alpha = \cos(\theta)$, $\beta = \sin(\theta)$ and ϕ is a phase shift incurred after multiple scattering events. Following the definitions of the Stokes parameters and using ~~the~~ appropriate basis ~~bases~~ the Stokes parameters for the scattered radiation can be found to be

$$
\begin{aligned}
I &= \alpha^2 + \beta^2 \\
Q &= \alpha^2 - \beta^2 \\
U &= 2\alpha\beta\cos(\phi) \\
V &= 2\alpha\beta\sin(\phi) .
\end{aligned}
$$

numbers

, in the circ. basis,

This implies that Stokes U is lost to Stokes V. A calculation of the phase shift ϕ incurred due to ASE ~~anisotropic resonant scattering~~ can be found in Houde et al. (2013).

6. CONCLUSION

We analyzed ~~took~~ polarimetric observations from the SMA archive of Orion KL, IRC+10216, NGC7538 and NGC1333 and examined them for CP signals ~~signals of circular polarization~~. The data were corrected for squint, a source of false Stokes V (italic) signals that arises due to a slight misalignment in the beams used to obtain Stokes V when performing observations ~~using the SMA's quarter-waveplate-based polarimeter~~. We found evidence of significant Stokes V in Orion KL, IRC+10216 and NGC7538 in the transitions of CO ($J = 3 \rightarrow 2$), SiO ($J = 8 \rightarrow 7$), CS ($J = 7 \rightarrow 6$), SiS ($J = 19 \rightarrow 18$) and $H^{13}CN$ ($J = 4 \rightarrow 3$)~~, but because of low SNR in the spectra we could not model the shape of Stokes~~ V. We also obtained much higher percentages of polarization than expected (ranging from 6-30% for V/I) due to the spatial filtering of large scale emission.

Theories that explain the presence of non-Zeeman CP ~~circular polarization~~ in molecular spectral lines rely on the conversion of background LP ~~linear polarization~~. The ~~several~~ detections in multiple lines and objects presented here indicate that such an effect is likely widespread and common.

Taking precise observations of CP along with LP and correcting for this conversion effect is therefore a critical step in polarization studies of the magnetic field in the interstellar medium.

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This is great! For the discussion: 1. I'm not sure that the "early detections" part should be there; I'll think about it but it may be better in the Introduction; 2. You need to discuss the high levels of CP you mention in the Conclusion; 3. You need to discuss why it is absolutely essential to measure CP if one wants to use LP to perform analyses (e.g., the DCF technique).