Be careful here, isn't a visibility the FT of a cross- or auto-correlation? with a mathematical definition this will become clearer (see purple comment at the top of p. 2).

ference of two beams a slight offset gives rise to pairs of positive and negative peaks of Stokes V, as ~~shown in~~ can be seen for example Figure 1. This offset likely arises because of slight differences in the index of refraction of the quarter-waveplate when it is rotated. ~~but has not been studied with the SMA as far as we know.~~

Because the visibilities are the Fourier transform of the intensity map, an offset in image space is equivalent to a complex factor in visibility space that can be absorbed into the gain coefficients.

Consider a map $I(l,m)$ that represents the true intensity I at angular position l and m. make this an equation An interferometer samples the Fourier transform of this map $V(u,v) = \int\int e^{-iul}e^{-ivm}I(l,m)dldm$. If the instrument introduces an ~~offset from some unknown position~~ arbitrary offset (l_0, m_0), then the final image we calculate is shifted such that $I'(l,m) = I(l-l_0, m-m_0)$ and the Fourier transform of the shifted map ~~is~~ becomes $V'(u,v) = \int\int e^{-iul}e^{-ivm}I(l-l_0, m-m_0)dldm$. Changing variables with $\alpha = l - l_0$ and $\delta = m - m_0$ ~~we see~~ move here

use an equation array in latex

$$V'(u,v) = \int\int e^{-iu(\alpha+l_0)}e^{-iv(\delta+m_0)}I(\alpha,\delta)d\alpha d\delta$$

$$\cancel{V'(u,v)} = e^{-iul_0}e^{-ivm_0}\int\int e^{-iu\alpha}e^{-iv\delta}I(\alpha,\delta)d\alpha d\delta$$

$$\cancel{V'(u,v)} = e^{-iul_0}e^{-ivm_0}V(u,v) \equiv g_{\text{offset}}V(u,v) \tag{2}$$

where we used the change of variables... .

~~This means that an offset will introduce a complex factor (g_{offset}) to the true visibilities.~~ It is therefore easiest to correct for the offset in visibility-space by using *Miriad* (Sault et al. 1995) to solve for the gain coefficients on each beam. Specifically the process is:

1. Observations are calibrated for gain and phase in the usual way using calibration observations of 'good' sources (usually quasars like 3C84, 3C454, etc.) (See Miriad User Guide Sault et al. (2008)).

2. Visibilities are split into line-free continuum data and line data. These are then mapped and used to obtain CLEAN models.

3. The separate continuum and line data are further split into LL and RR visibilities. *Miriad*'s `selfcal` is used on the continuum data to solve for the gain coefficients of each antenna and each polarization (L or R). This is done by minimizing the difference between measured visibilities $\mathcal{V}_{ij}$ of antennae i and j and model visibilities $\hat{\mathcal{V}}_{ij}$ according to $\epsilon^2 = \sum|\mathcal{V}_{ij} - g_i g_j^* \hat{\mathcal{V}}_{ij}|^2$ for each of the correlations LL and RR (Sault et al. 2008; Schwab 1980). The model visibilities used are those found earlier.

We thus find the aforementioned complex offset that multiplies the visibility.

You seem to be using a new notation here.

4. The gains found from the continuum LL data is then applied to the line LL data, and similarly for the RR continuum and line data.

5. The different visibilities (LL, RR, RL, LR) are recombined and inverted to produce corrected maps. Spectra can be obtained either from the corrected visibilities or the maps.

Figure 1 shows maps before and after this correction is applied, for ... → more details on the object used for this example.

4. OBSERVATIONS

We collected radio interferometric polarimetry observations from the Submillimeter Array (SMA) archive that had been measured using the circular feeds, a similar setup to that used by Muñoz et al. (2012) to measure circular polarization in Sgr A*. Because the archival observations were not taken with measurements of circular polarization in mind the SNR is often low, and we had to average velocity channels to increase ~~the SNR~~ it at the cost of spectral resolution. This generally increases the SNR from 3-4 to 6-10.

The four objects we present here are Orion KL, NGC7538, IRAS2a A? in NGC1333 and IRC+10216. The first three are well-known star-formation regions, while IRC+10216 is an evolved carbon star. We find significant Stokes V signals in all objects except for NGC1333.

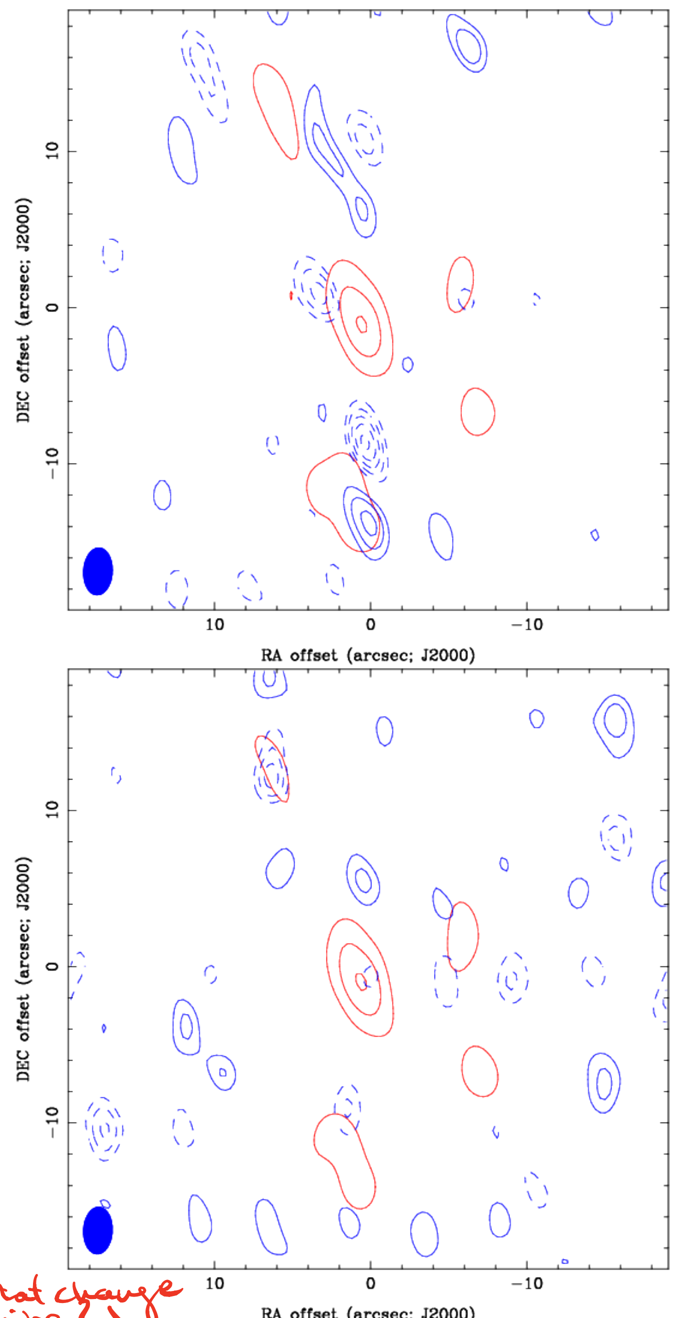
The visibility data are corrected for beam squint, ~~an instrumental artifact that gives rise to~~ as explained on the previous section in order to reduce spurious Stokes V signals. ~~Squint~~ As previously mentioned squint typically causes distinct pairs of positive and negative peaks of Stokes V throughout the inverted image. ~~Maps are then made of the continuum and lines for each object.~~ repetition The squint correction is confirmed visually by inspecting the Stokes V maps, where we see the pairs of peaks largely disappear. ~~More details on the squint correction will be given in Section 3.~~

Figure 2 shows corrected Stokes I and Stokes V spectra (left) obtained at the peak of Stokes V on the corresponding maps (right). A comparison of Stokes V spectra before and after correction are shown in Figure 3. Notice in all cases the Stokes V signal decreases after squint correction. Stokes V can also be found in the average of all the visibility data, though the significance is 3-5σ in that case compared to approximately 6-10σ when the spectra is taken from the inverted maps. This indicates the detections are not simply the result of the inversion process that creates the maps. We present here only the map spectra. In general the peaks of Stokes I and Stokes V ~~are not at the same map position~~ do not coincide.

You need to say that the maps are about CO.

what do you mean?

In Orion KL the lines of CO ($J = 3 \to 2$ at 345.8GHz) and SiO ($J = 8 \to 7$ at 347.3GHz) are both bright (peak Stokes I of around 20 Jy/beam and 55 Jy/beam respectively; not shown) and both show Stokes V signals. The CO Stokes V signal has an antisymmetric structure, 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

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.

Repetition

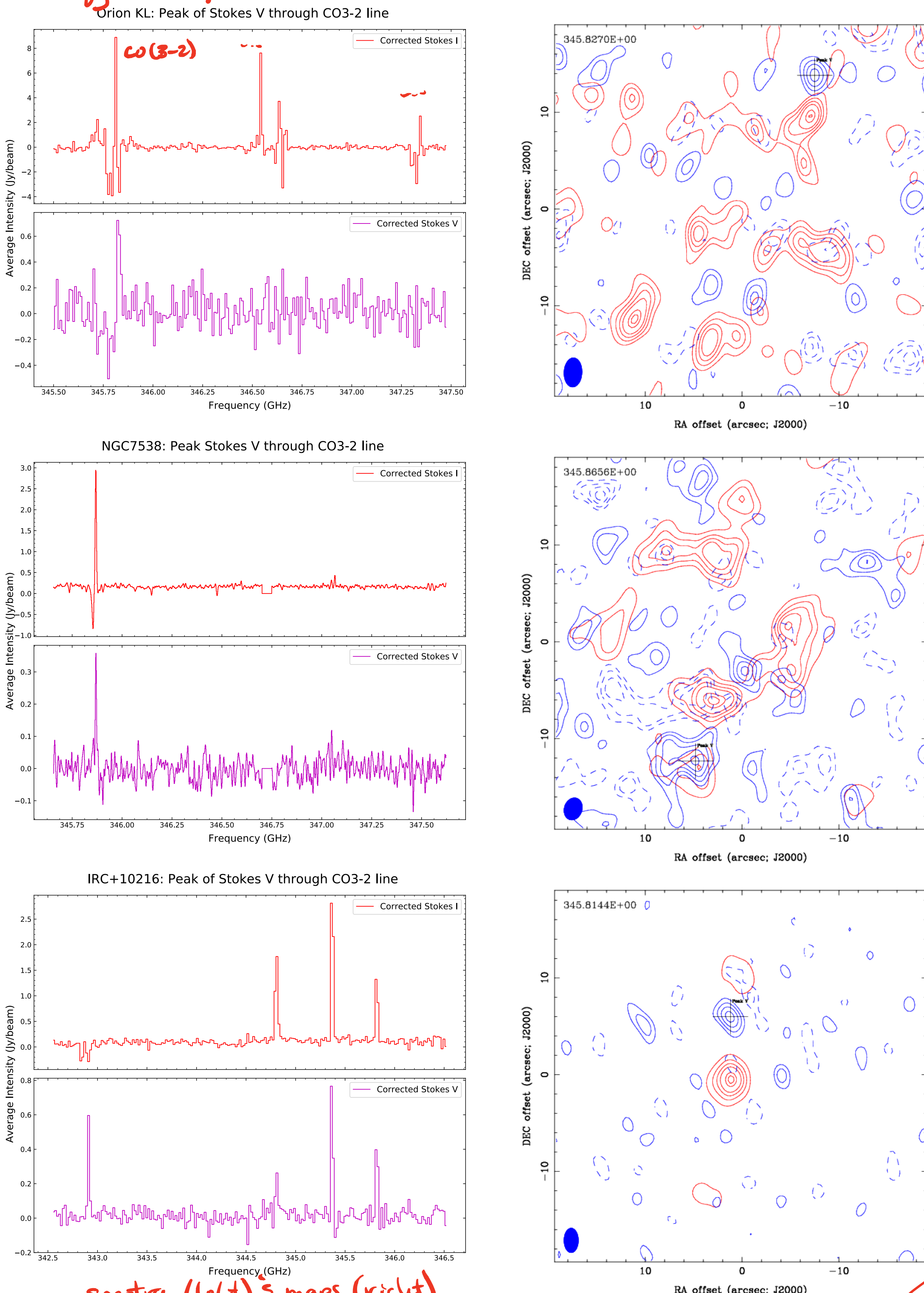
In the maps for Orion KL and IRC+10216 shown in Figure 2 there are no negative peaks around the peak of Stokes V. However in NGC7538 there is quite a large negative Stokes V peak near our chosen peak that may indicate squint. The top panel of Figure 1 shows what 'squint peaks' look like (we know these 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.

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 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 repeat here the arguments made in Section 4 that these detections are

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



what does that mean?

spectra (left) & maps (right)

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, NGC7535 and IRC+10216, respectively.

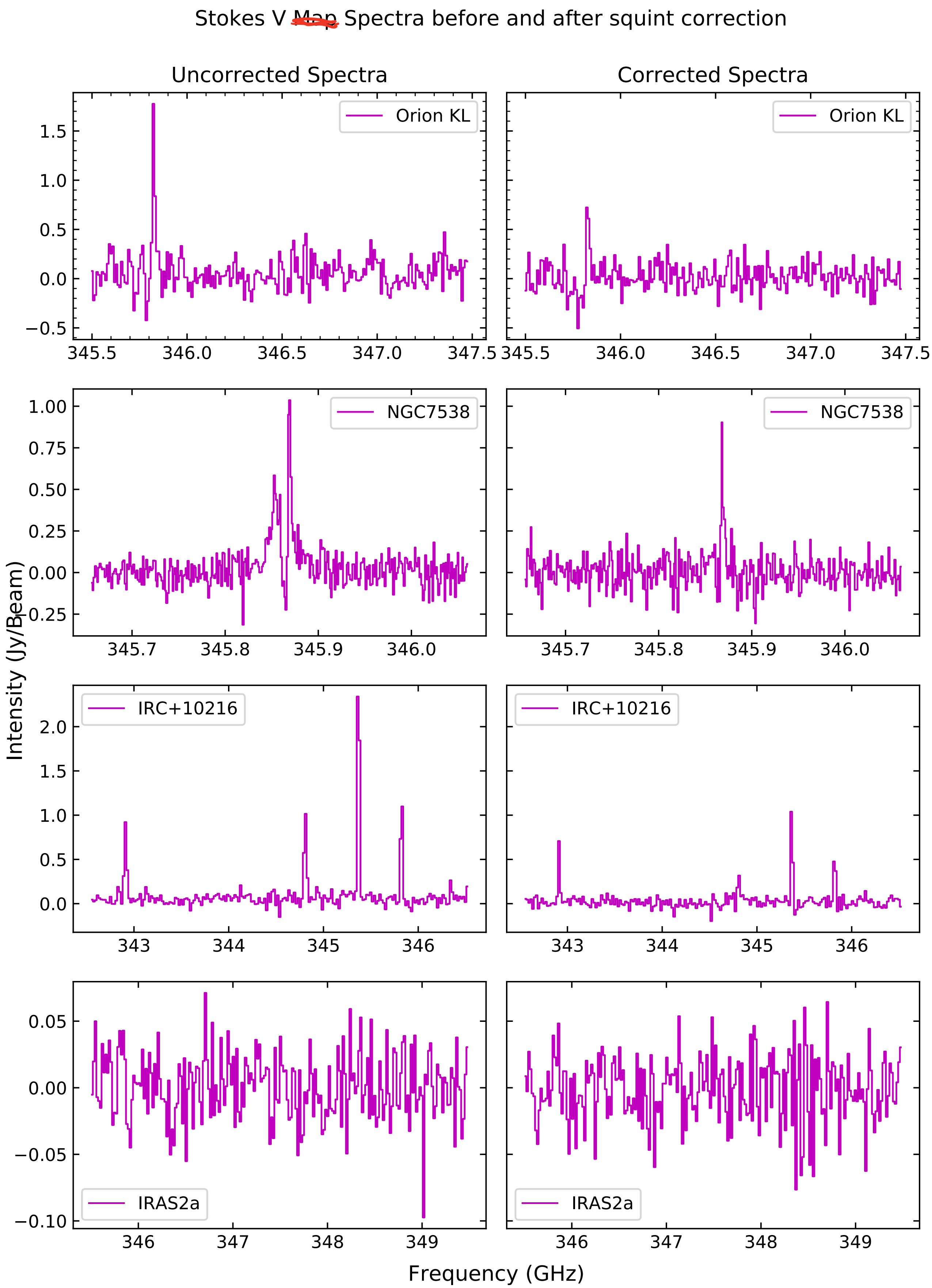


Figure 3. Stokes V spectra of all objects before and after squint correction. *Miriad*'s `maxfit` is used on the CO map for each respective object to obtain the location in the image where the Stokes V signal at 345.8GHz is maximum, and a ~~spectra~~ spectrum is obtained through that point. Note that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

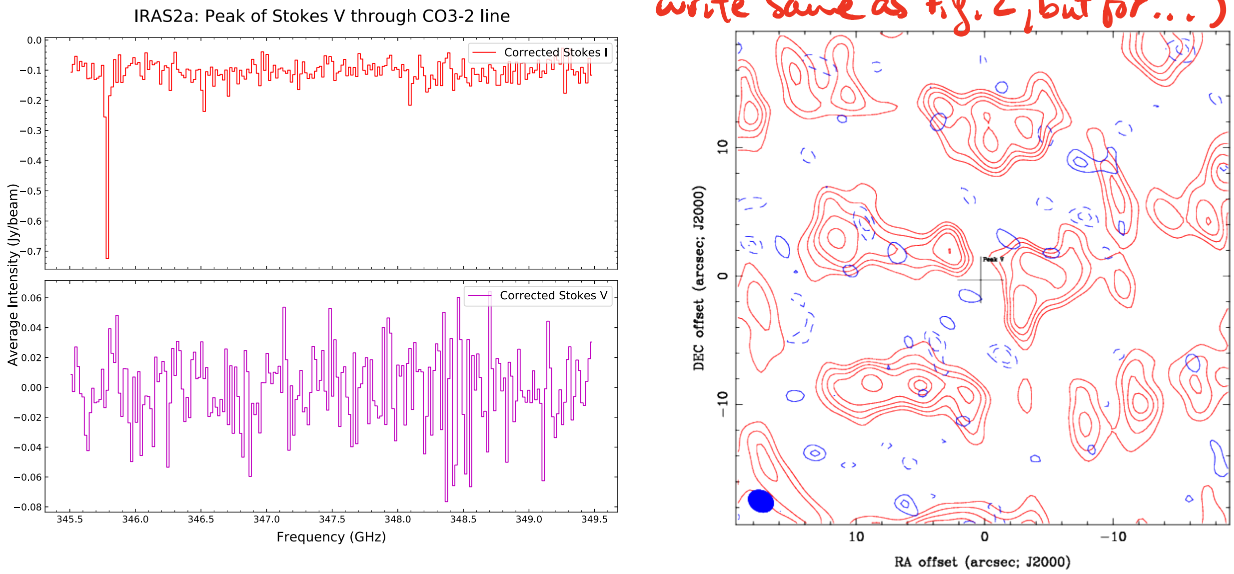


Figure 4. Corrected maps of the CO $J = 3 \rightarrow 2$ line and corrected spectrum for NGC1333 (IRAS2a). No significant Stokes V signal is detected here, probably because the object is too dim. Contours are the same levels as in Figure 2 and the spectrum is obtained the same way.

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. 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 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 IRC+10216: the 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).

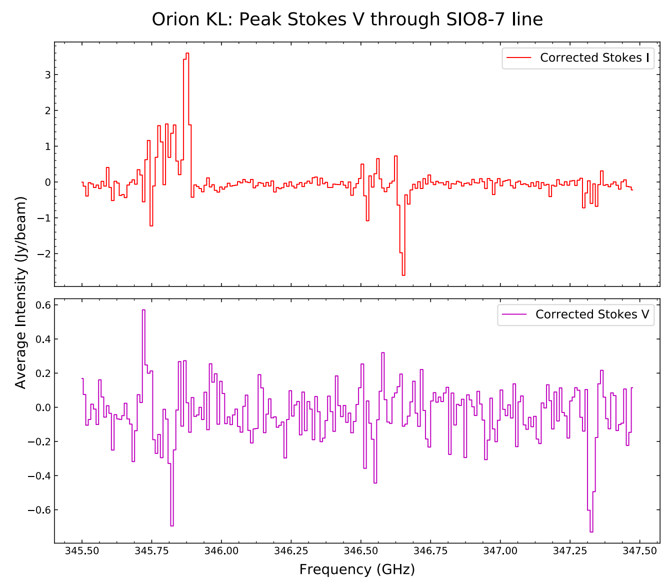


Figure 5. Peak Stokes V signal for the SiO ($J = 7 \rightarrow 8$ at 347.3 GHz) transition in Orion KL. Note there is also a strong Stokes V signal in the CO ($J = 3 \rightarrow 2$ at 345.8 GHz) transition here. The SiO signal is purely negative but the CO signal is antisymmetric.

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 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