## Heterodyne Discussion Session

### Capabilities

*What instrumentation and facilities do we currently have access to?*

### Demands

*In the next 5-10 years:*

*What instruments/facilities are needed for the science goals?*

### Advancements

*In the next 5-10 years:*

*What instruments/facilities are we building?*

*What instruments/facilities can we get involved with?*
Capabilities

What instrumentation and facilities do we currently have access to?

- 1 Gb per second current data rate
Demands

In the next 5-10 years:
What instruments/facilities are needed for the science goals?

- Currently less proposals at 230 than for 345 GHz - increasing speed to observe dense gas tracers would be useful
- Heterodyne and Continuum should complement each other (overlap in frequency for fair comparisons)
- $^{12}$CO(3-2) important for polarization science (GK effect). Velocity dispersion information from C18O(3-2) traces same critical density as dust
- LNA cover full bandwidth $^{12}$CO(3-2) and $^{12}$CO(2-1)
- Take advantage of altitude: 345. Avoid continuum competition: 230. 230 has a strong case (strong lines)
- Flexibility will be key
- We need a plan for the 50M telescope age
- Polarisation may increase in importance - Goretex still concern
Demands

In the next 5-10 years:
What instruments/facilities are needed for the science goals?

- Blind survey (high redshift) with a wide field of view and wide bandwidth is ideal but initially this is unrealistic
- High redshift - a larger backend to detect multiple lines would be ideal
- Map magnetic field in galactic plane (Planck has a lot of contamination)
- 3%/5% CO polarisation - so it is detectable
- Mapping sky, usually interested in a particular set of lines. Divide spectrometer’s bandwidth
- ALMA has 4 windows (16GHz) - 200GHz to 400 GHz is feasible
- On chip spectrometers? Spectral resolution is hindered
- Need to resolve velocity dispersion with significant resolution (comparable to sound speed of gas)
Demands

In the next 5-10 years:
What instruments/facilities are needed for the science goals?
- Wide enough bandwidth to observe several molecules simultaneously - multiple transitions
- Common user telescope - need to cater to a variety of projects
- Future spectrometer may have much more flexibility (flexible resolution)
- 1 pixel, but many ADCs for wide bandwidth - we would need to invest a lot in downconverters, IF/LO electronics - large cost
- Collaboration with SMA (zero-spacing) - wide bandwidth SMA should be complemented by our instrumentation (and vice versa)
- Extragalactic (even nearby) weak signal - wide bandwidth is key
- High redshift engines worthwhile because of the large amount of information in a single pixel
- 100 pixels - large-scale structure
- Don’t need high resolution across full (very wide) bandwidth
In the next 5-10 years:
What instruments/facilities are needed for the science goals?

- Smaller array heavily optimized?
- If 100 pixels work, it would be very beneficial but the current technology is not scaleable
- Data Rates - how to handle all of the data produced?
- SKA and LSST is developing potential solutions
- Archive system on site
- Matt: Map Andromeda
Advancements

In the next 5-10 years:
What instruments/facilities are we building?
What instruments/facilities can we get involved with?

- 100 pixel heterodyne instrument at JCMT (2nd generation HARP 345 GHz)
- Factor of 14 improvement over current instrument. Square degree 0.1K in 6.5 hours
- Should we consider 230GHz as opposed to 345GHz to take advantage of time on sky
- Should be used on 50M class telescopes
- This is an ambitious project and will require new solutions for backend - the next generation of telescopes will rely on these solutions
- Backend cost (with current technology) is very high
- Technology is getting better each year and the cost is dropping
- Cannot simply scale up current technology (prohibitive)
- Need to define technological challenges
- Modular (300 pixel system eventually?)
Advancements

In the next 5-10 years:
What instruments/facilities are we building?
What instruments/facilities can we get involved with?

- GPU cards - 1 card for 1 pixel, but this ratio is improving
- Perhaps not a major challenge but there are many details to consider
- Additional sampler required?
- Using less state of the art detectors can limit the cost
- In 1990s superconducting computers already being developed
- Fabrication technology same as SS - need science drivers
- Higher sampling rate = less resolution. Interferometers have cross-correlation (forgiving process). Single dish is more complicated - look to IRAM?
- Local Oscillators (off-the-shelf) exist at these frequencies
Advancements

In the next 5-10 years:
What instruments/facilities are we building?
What instruments/facilities can we get involved with?

- ADC developed for CASPER reasonable price? (ASIAA)
- Cost/Benefit analysis - it is likely that we can’t have everything
- How many pixels are empty? We need to optimize