The Submillimetre Spectrum of Mars as seen by Herschel-SPIRE

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On behalf of the HssO Consortium

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The SPIRE FTS- reminder
SPIRE FTS Capabilities

• Entire range covered simultaneously
• Continuum measured as well as spectral lines
• Adjustable spectral resolution: $\Delta \nu (H, M, L) = (1.2, 6.7, 25)$ GHz
• Frequency calibration accurate to $< 1/10$ resolution element
Typical Observations with SPIRE FTS Bright Source mode

- Instrument designed to be as sensitive as possible
- Telescope represents flux of ~100’s Jy
- Sources >> brighter saturate the detector electronics
- Need to reduce gain and/or sensitivity
- Gain variable by putting detector bias out of phase
- Sensitivity variable by increasing the bias
- Test observations to see if it works
- Is it possible to observe Mars?
- Is it possible to calibrate it?
Mars Observed on OD176 (2009 November 6)

- Answer – yes!
- 2 repeats – 264 seconds
- Data processed through non-standard pipeline
- Uranus (Moreno 2010) used as the calibration standard
- Gain correction achieved using calibrator flashes to scale continuum
- Some ”clipping” in the interferogram leads to distortion of SSW spectrum

![Graph showing spectral data](image-url)
Interferograms and PCAL Flashes

- Detector temperature varies ~linearly with power
- $\Delta T$ can be used as linear proxy
- After conversion to spectral domain can scale gain using response to PCAL...
- ..or to the telescope
Mars Model in RADTRANS (Irwin 2009)

- Standard thermal profile (Seif 1982)
- Northern “Summer”
- Not quite right for November 2009
- Continuum calculated using Lellouch (2008) model (220 K) and emissivity of 0.95 (Burgdorf et al 1998)
- Constant mixing ratios of $1.2 \times 10^{-3}$ and $9.0 \times 10^{-3}$
Varying the mixing ratio

• Attempted to get better fit to line widths
• Variation with pressure requires large increase in surface mixing ratio
• Variation with temperature better but still lines are narrower than prediction
• Need HIFI.....
Mars taken on OD327 (2010 April 6)

- Using “High Bias” bright source mode
- On this OD there was a 6” offset in the pointing
- Calibrated using the telescope as fixed source
- Leaves structure in the spectrum
SLW compared to OD176
SSW compared to OD176
Conclusions

• We can use SPIRE to observe Mars – not an obvious statement
• We can calibrate the spectrum to reasonable accuracy – not an obvious statement
• First order model shows good agreement over most (all?) water and CO observations in spectrum -....
• A second observation off axis seems to show some unexpected emission features
• HIFI observation required to refine modelling and confirm (or not) emission features
• Further observations will look for temporal variability
• Saturn should also be observable with SPIRE