3D interactive visualisation tools for HI spectral line imaging

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3D interactive visualisation tools for HI spectral line imaging

- Explore the signatures of HI in galaxies
- Enhance modelling of HI structures
- Provide an affordable and fast environment
- Avoid diversity of tools
Challenges for calibration

- Replace single-pixel detector with array of detectors.
- Turn single dish into a camera.
- Apertif: turn the WSRT into a survey instrument.

Small field of view of current radio telescopes is a major limitation. Observing large survey areas with good sensitivity takes too much time.

Apertif: phased array feeds expand FoV

- 0.25 square degrees
- 8 square degrees

- single element
- 64 elements
- full PAF in focal plane

FoV expansion increases survey speed by a factor ~20
Challenges for calibration

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8 square degrees

Incoming data rate:
\~ 4 TB/day

Archive data rate:
\~ 2 PB/year

FoV expansion increases survey speed by a factor \~20
An example data cube of ~ 8 square degrees

- one Apertif pointing will deliver ~100 detections occupying ~ $10^9$ voxels
- one pointing has ~$10^{11}$ voxels (~1 TB): so 99% is noise
Find and characterise 3D structures automatically

galaxies in the Ursa Major cluster (courtesy Busekool and Verheijen)

rendering by Davide Punzo
Signatures of gas accretion and removal

Common to these tell-tale signatures:

- low column density
- unusual kinematics

*good visualisation techniques can help finding such features*
separate non-circularly rotating (extra-planar) gas (green) from the rotating disk by using a model to describe the disk (blue)
Visualisation goal

Present 1-D, 2-D, 3-D and n-D data in a comprehensive way and accommodate interaction with the data with an emphasis on desktop solutions should include volume rendering, advanced filtering, data selection and model comparison

Implemented a module SlicerAstro into 3D Slicer (www.slicer.org)

Punzo et al. 2015, Astronomy and Computing, 12, 86
Punzo et al. 2016, Astronomy and Computing, 17, 163
Why 3D Slicer

Synergies between astronomical and medical visualization

Open-Source

www.slicer.org

Long-term maintainability

Well documented:

- SlicerWiki
- github.com/Slicer/Slicer
- Mantis bug report

See also Punzo et al., 2015, Astronomy and Computing, 12, 86.
3D Slicer provides full linked views, not just slices
SlicerAstro in 3D Slicer (www.slicer.org)

- added FITS, WCS and physical coordinates
- add SlicerAstro via Extension Manager

github.com/Punzo/SlicerAstro/
SlicerAstro: 3D selection

cloud lasso selection
Visualisation: let's get to work

cloud lasso selection

cloud lasso selection on filtered data

same selection on original data
SlicerAstro: masking after selection

three selections made on the filtered data
Original data

Filtered data

RA - Dec display

RA - Vel display

Vel - Dec display
Summary

now available in SlicerAstro:

- 3D rendering capability with coupled 2D displays
- filtering for faint feature discovery
- selection using cloud lasso plus thresholding
- fits input and output (including the segmentation)

under development:

- direct model comparison
- model aided segmentation
- interactive model tuning

github.com/Punzo/SlicerAstro/
Summary

Thank You

Stay Tuned

github.com/Punzo/SlicerAstro/