ALMA science software development

Mark Lacy

Workshop logistics

* Wireless is nraoPUBLIC

* Lunch provided, conference dinner tonight, Downtown Grille, Charlottesville, on the Downtown Mall. www.downtowngrille.com

* See Lyndele for reimbursement information (invited speakers)

* Twitter hash tag #ALMASW11

Aims of the workshop

✳ Explore collaborations for development of software for ALMA (and other radio astronomy facilities, particularly EVLA).

✳ Varied participation from NRAO through Universities to private companies.

✳ Seed funding for US collaborations will be available (similar schemes in EU and EA, on different timings).

✳ Ultimate results are proposals to the ALMA development program (Al Wootten's talk), perhaps to other funding sources (NSF in the US).

Data processing challenges

* Large data volume (~1TB/day+)

* Pipeline "heuristics" (decision engine)

* Imaging algorithms and image reconstruction using incomplete information. (Compressive sensing)

Image theory digression (why interferometry is hard)

FOURIER TRANSFORM (OPTICS)

2 arcsec

SKY　　　**PUPIL (APERTURE) PLANE**　　　**IMAGE PLANE**
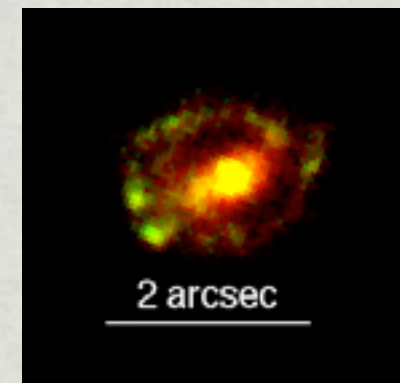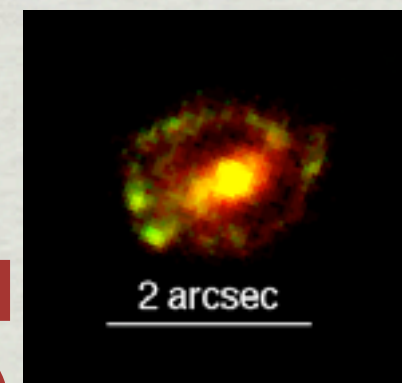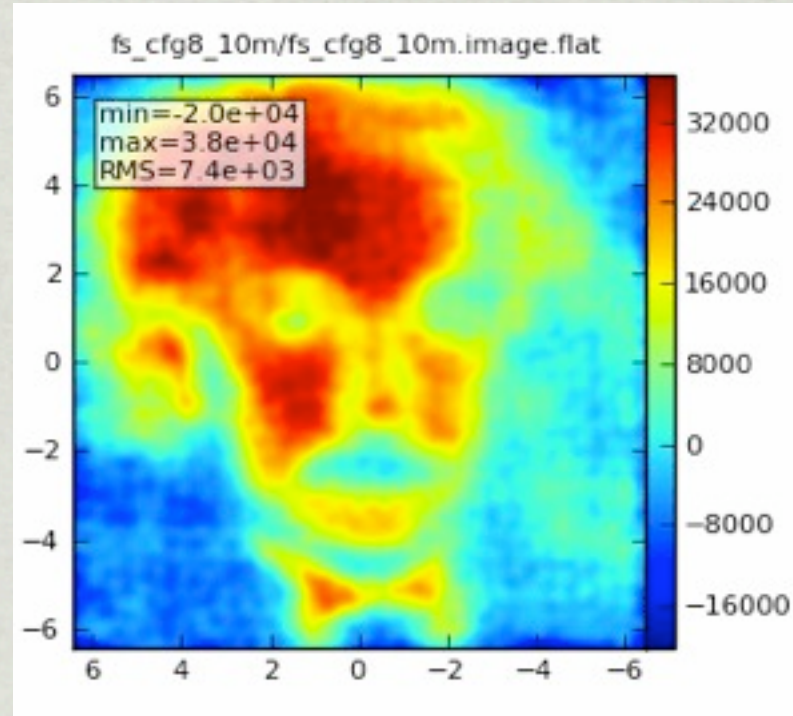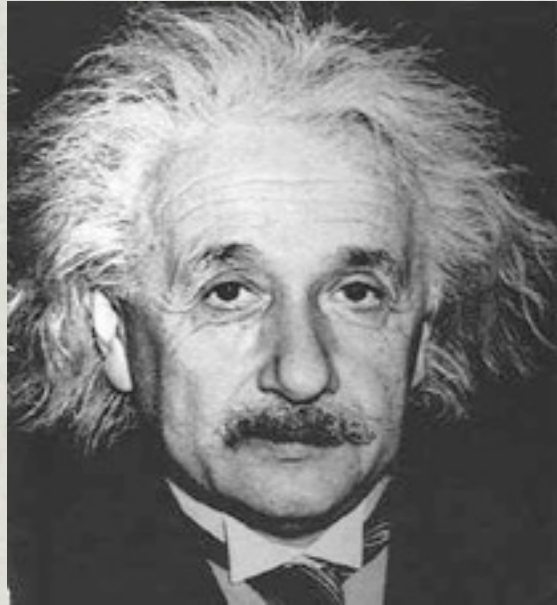
FOURIER TRANSFORM (SOFTWARE)
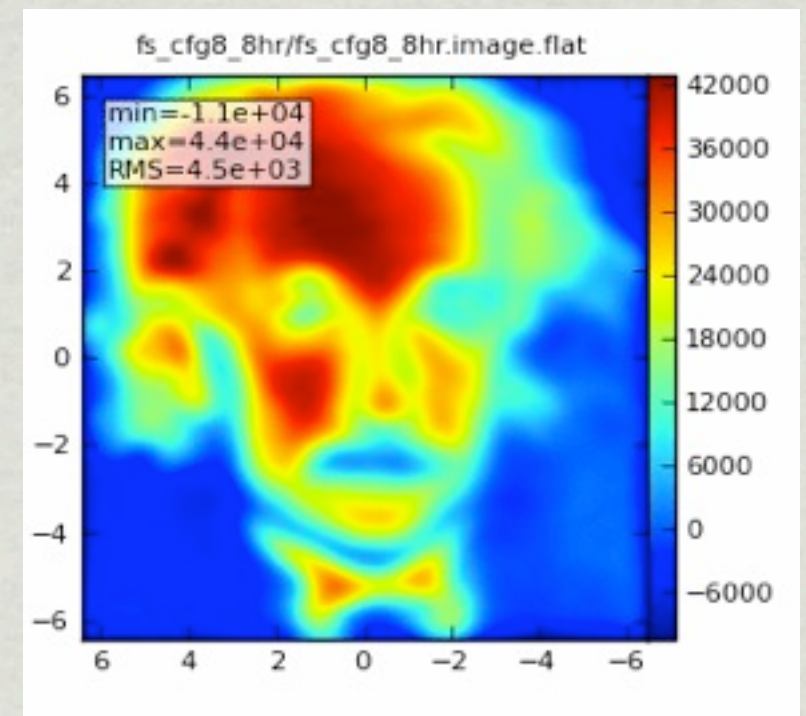
2 arcsec

SPARSELY FILLED APERTURE FOR INTERFEROMETRY MEANS ONLY PARTIAL IMAGE INFORMATION CAPTURED

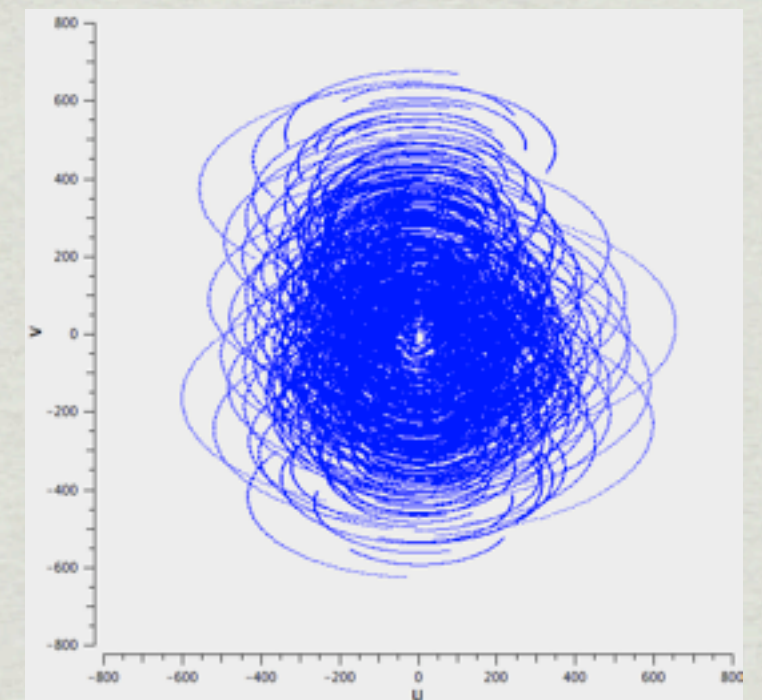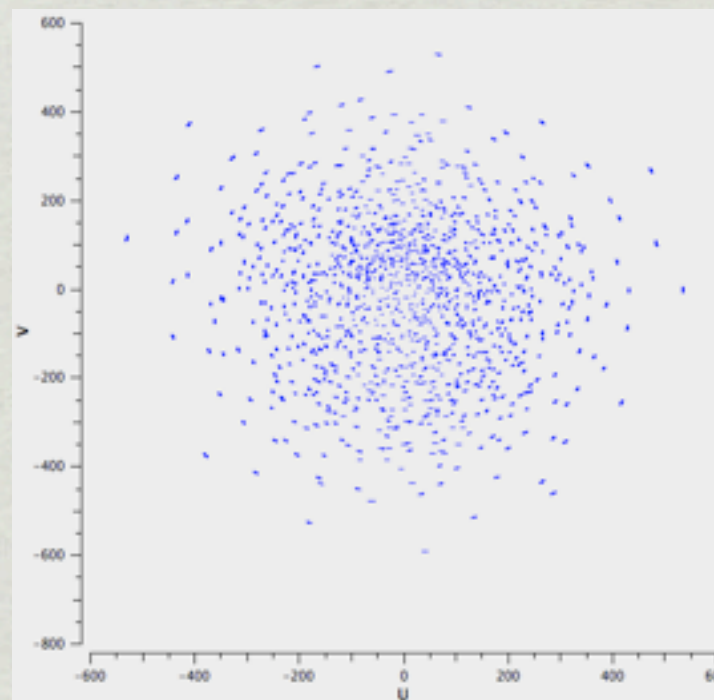# Example: Einstein's face

10 MIN   **8HR**

Imaging challenges

* Large degeneracy in reconstructed image given data, even when spatial frequencies are within sampled range.

* Missing information has important implications for automated feature identification and analysis.

* "Human element" - essentially a set of sophisticated priors - needs to be captured by pipeline software.

Data visualization challenges

* Interaction with a large datacube

    * Rendering

    * Server vs client side (3840x1024x1024x4B=16GB)

    * Interpretation of x,y,velocity data

* Integration of software from other fields into astronomy, or roll our own?

Data analysis challenges

* Automated feature extraction from data cubes

* Feature characterization in datacubes

* Line forest identification

* Modeling of complex ISM emission

Other astronomical fields

- Large astronomical surveys in the optical/near-IR use automated extraction based on isophotal analysis or point source fitting (SExtractor/DAOPhot/Mopex/Starfinder)

- No astronomer looks at every galaxy (citizen scientists may).

- But images all 2D, sources discrete (usually).

- Only limited work on cubes (IFUs)

Broad questions

* Path from "art" ➤ "priors" ➤ "heuristics" ➤ image cube

* Path from image cube to Nobel Prize

  - How do we understand and interact with a 100GB datacube?

  - How do we model the complex structures and chemistry?

Narrow questions

* How do I include my script in CASA?

* Which software applications can we start writing the specs for now?

* Which collaborations can we form to work on these problems?

Outline

* Today - intros to program, CASA, broad questions of interaction with image cubes.

* Tomorrow - Spectral line forest modeling, automated feature detection and characterization in datacubes.

* Friday (am) - data processing algorithms, methods and incorporation into CASA. Wrap-up.

Dinner 6:30pm Downtown Grille
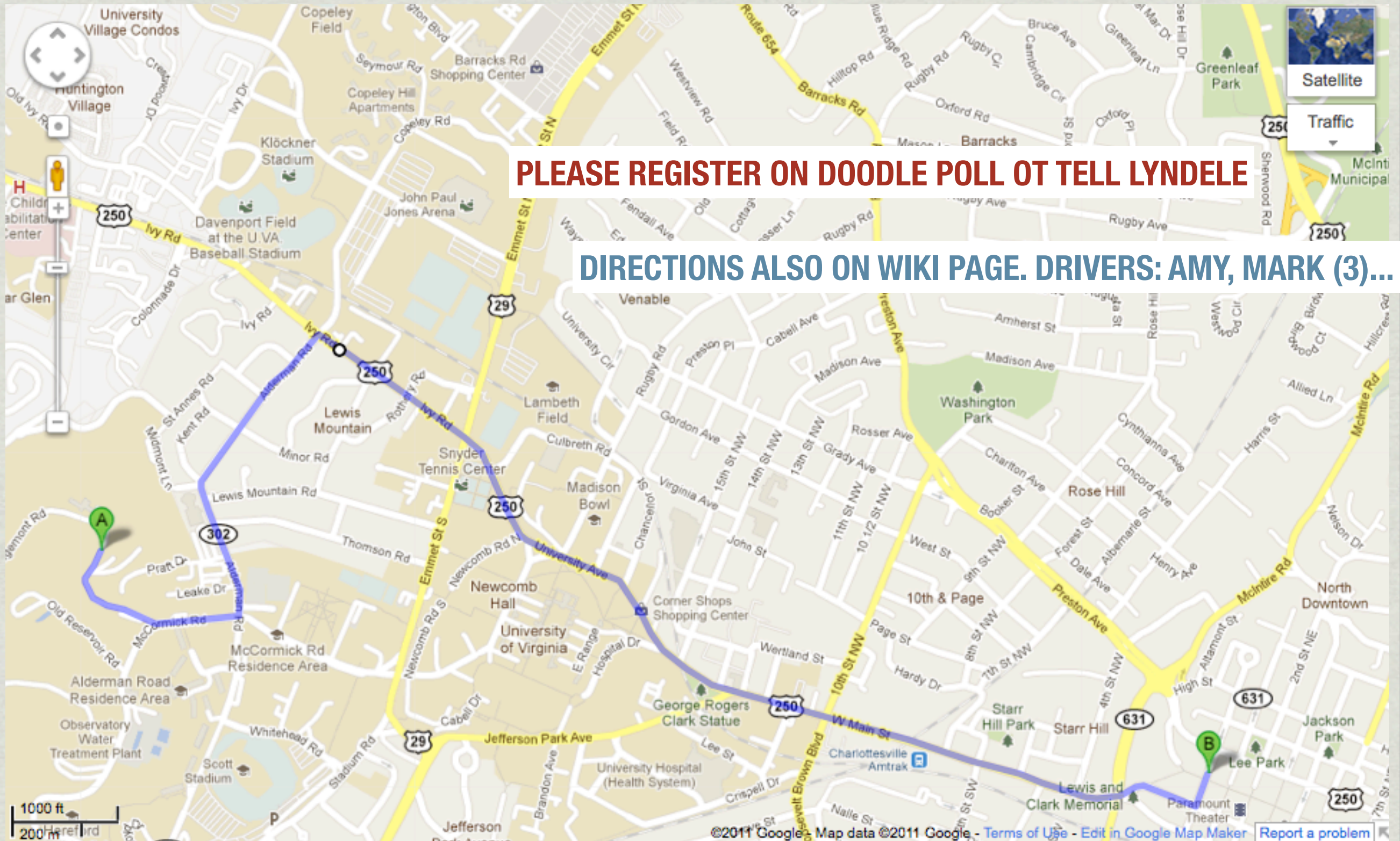
PLEASE REGISTER ON DOODLE POLL OT TELL LYNDELE

DIRECTIONS ALSO ON WIKI PAGE. DRIVERS: AMY, MARK (3)...

Peta data on the human scale

❋ Visualization - roll our own or not?

- other stuff out there (National Labs, medical imaging), but hard to do coordinates.

- Adapt current viewer? (ds9, casa, gaia...)

- How do you train people to see structures in x,y,v space?

- server vs client side.

❋ maintenance

❋ social collaboration and networking

Thanks

* Lyndele von Schill

* Dale Nordstrom and Gene Runion

* Dong-Chan Kim

* SOC, session chairs, panelists

* Everyone for coming!

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SEND ME YOUR TALKS!

Monday, January 30, 2012

Wrap up - portals and interfaces

* User portal/archive access/pipeline job control - can ALMA/NRAO learn from CyberSka and/or VAO?

* 3D Astronomical Visualization - the time is right?

  * pick something as a basic platform to build WCS support on etc that can work on client or server side.

  * Most of the optical/NIR community not so interested right now? But ESO is - ALL E-ELT spectrographs will be IFUs!

  * Use broader community (including outside academic astronomy?) to help pick, document etc...

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Chemistry

* Numerous opportunities small (WEEDS-level) to large scale ISM chemistry modeling projects.

  * WEEDS small effort but well-documented and useful.

  * Maps of molecules clearly of great value and will be a major product of ALMA. Radiative transfer and excitation issues may limit what can be done, but this mapping should be supported.

* Clear opportunities for public engagement (adopt-a-molecule etc)

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Feature finding and identification

* Clump/source finding

  - quick but robust and user-friendly implementation of existing algorithm(s) (SExtractor model) or

  - try to write something better? (but algorithm development timescale long)

  - Use cases important to develop specific software.

* Simulations/toy models (cf. artdata in IRAF).

Small projects

* Clearly identified need for small efforts for specific projects (few FTE months) that could be part of CASA.

* If we can make CASA even more easy to produce tasks for (easy to use toolkit, easy integration) this will help.

* Also need a good path for contributed tasks in CASA (user forum to integration into regular CASA releases). "Survival of the fittest"

  * Way to involve the community for "free"

* No obvious funding line for these small projects though.

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Maintenance

 ✳ Maintenance... the several $M question...

 - Hardware needs to be built to certain standards (e.g. new receivers should fit in FE, not draw too much power, interface with ALMA electronics...) So why not software?

 - Strict (CASA) software standards? Or looser (e.g. must work in CASA environment). But either way maintainable by CASA engineers.

 - Proposals to the ALMA development funds should include a maintenance plan.

* Call for development studies is coming soon.

  • Modern (and forward looking) Viewer

  • Simplified Access to data products to enable small scale development (1 month projects)

* Other opportunities:

  • Chemical & Radiative transfer modeling

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