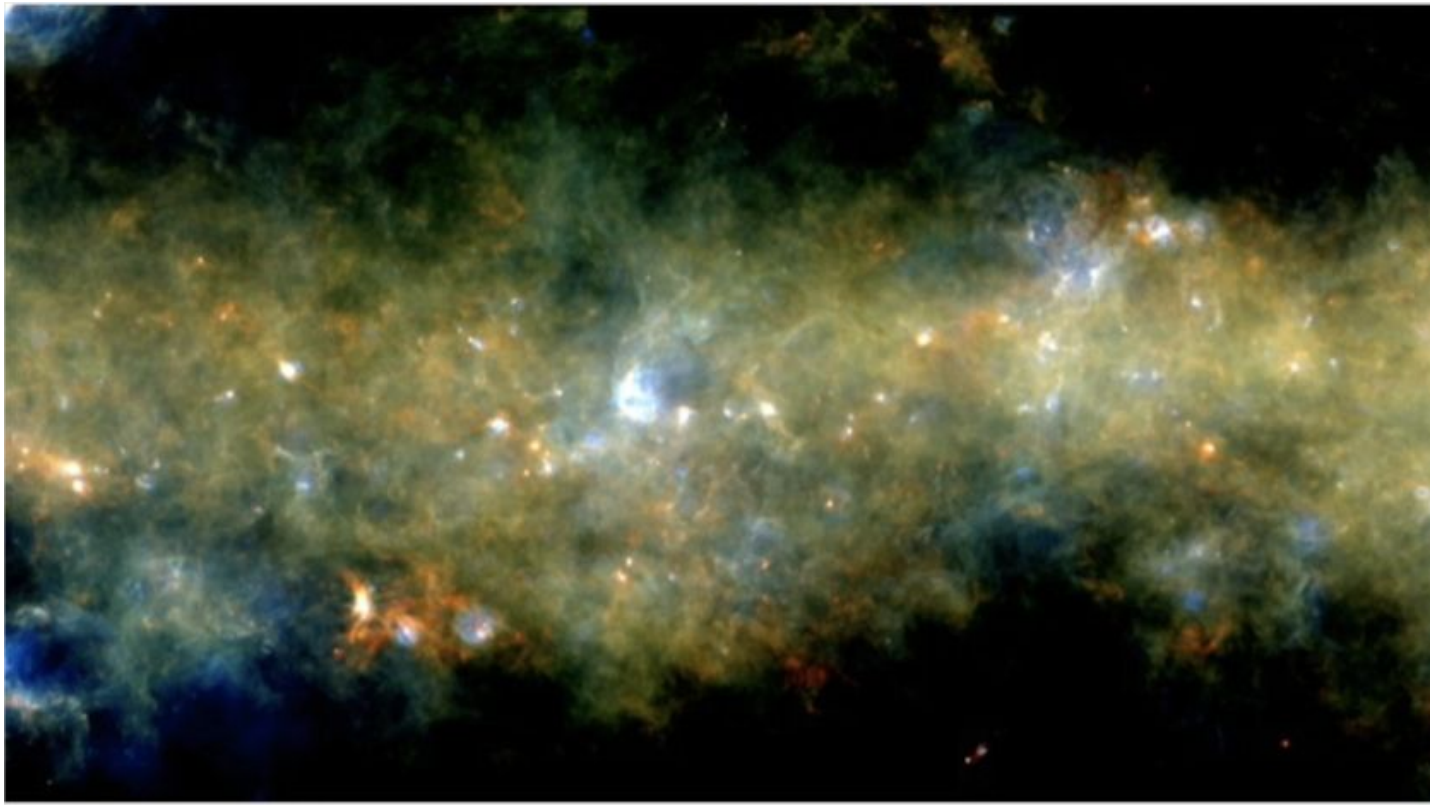
Star Formation

Parallel Session

Science Driver #1: Star Formation in Context (We could have said this in 2010)

- Global conditions for star formation
- Effect of environment and feedback
- Modes of star formation (low-, high-mass, isolated, clustered, etc.)

There is science here, but it’s hard to grok.



And we just want more of that.
Recommendations for Observational Facilities

Need for large-area surveys: to capture “complexity” of star formation process : WFIRST, LSST, Euclid, JWST, Origins Space Telescope

2. Resolution: need ~5” to allow resolving FIR clumps into cores, and to resolve filamentary networks at distances of several kph (e.g. across the Galaxy).

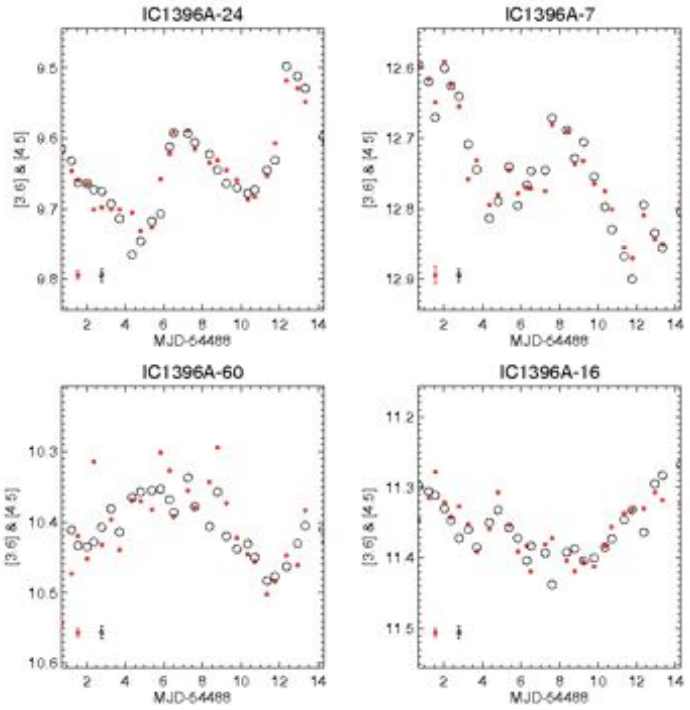
3. Sensitivity: Assuming a 30% “efficiency” in converting clump mass into stellar mass, observations of the clump mass function need to be complete for masses greater than 0.03 $M_{\odot}$.

4. Multi-wavelength observations: observations from X-rays (YSOs) to cm-wavelengths (cores), to capture multi-faceted aspect of SF process

Overcoming Obstacles

- Data *complexity*, not volume
  - Object detection / identification in a single band not straightforward
  - Spatially varying background
  - Changing resolutions across wavelengths
  - Strong extinction effects
  - We are not making use of all the data currently available
- Machine learning may help
  - Not clear that this is being fully exploited, yet
  - Lack of expertise
  - The experts say you may need more computing than the data volume suggests
  - Lack of computing facilities or knowledge of available facilities or how to use them

Science Driver #2: Accretion traced by YSO multiwavelength variability (new appreciation since 2010)



Light curves at 3.6, 4.5 um for stars in IC1396

L. Rebull & YSOVAR team

Overcoming Obstacles

- Complexity: Current high-cadence data shows a startling diversity of multiwavelength light curves. How to make sense of this?
  - More data to find trends
  - New techniques to find trends
- Unapproachability of radio data
  - VLA and ALMA science-ready data products

Science Driver #3: *Existing* spectroscopy is underutilized

- This isn’t science as phrased, but it is a shame.
- Herschel HIFI clearly has a lot of info, but the community doesn’t have the WHAT to exploit it.
- Do ALMA folks see the same thing?
- Will we see the same for new observing facilities?
  - SPHEREx
  - Origins Space Telescope
    - Origins Survey Spectrometer (High resolution spectroscopy (R > 500) across the sky)

Overcoming Obstacles

- High Level Products are needed to make the data more approachable
  - ALMA has an automated line finder in the works.
  - Visualization
  - Search by line
- Laboratory astrophysics results need to be more available to the star formation community

Even if we get all the data we ask for, we will have trouble extracting and synthesizing the information from it. We need high-level products and machines and lab data.

And more data.

Incoherent Notes Follow

Notes on future time domain studies

- Gaia doesn’t do Galactic Plane very well because of dust and has low cadence
- ZTF - sparse cadence
- DES - how would you mine this?
  - NOAO source catalog has time series
  - Pre-computed statistics
- Won’t be addressed by JWST.
- LSST - sparse cadence in the Galactic Plane
- WFIRST - microlensing survey 15 min cadence

Responsibilities

Mission is responsible for high level products that can be used for many purposes

Archives should be responsible for providing tools to analyze the data

Science ready data products - Time domain is the driver

VLA and ALMA data sets

Means for non-radio astronomers