

Interstellar Medium, Stars, and Planets

Working group #4

May 21, 2004

Berlin

Working group questions

- What scientific issues do we want to address?
- How rapidly are we making progress in this issues? (opportunities)
- What facilities or projects will address the critical questions?

Interstellar medium

- What are the dynamics and evolution of the ISM in the Galaxy (the life cycle)
- What is the role of the ISM in other galaxies?
- What is the evolution of the I(G)SM over cosmic time?
- How does interstellar matter evolve to stars & planetary systems?
 - What is the origin and evolution of dust?
 - Can we understand the details of dust formation?
 - What is the origin and evolution of interstellar molecules?
 - Chemistry of the ISM including dust-catalysis
- What is the origin and role of magnetic fields?

Stars

- What determines the initial mass function?
 - Is it universal? How do we understand its variations?
 - What governs the multiplicity of stellar systems?
- What physical processes determine the characteristics of stars throughout their lifetimes?
 - Convection, mixing, nuclear reactions, magnetic fields, etc.
- What physical processes govern the stellar environments throughout their lifetimes?
 - Jets, disks, outflows & winds
- What is the origin of the heavy elements and how are they recycled into the ISM?

Planets

- How common are planetary systems?
 - How are planetary systems born and evolve?
- What are the characteristics of planetary systems?
 - What is the Initial Planetary-Mass Function?
- What are characteristics of planetary atmospheres & oceans?
 - Frequency, composition, origin?
- Is there extra-terrestrial life?

Interstellar medium: facilities

Italics denote ongoing/rapid progress

- What are the dynamics and evolution of the ISM in the Galaxy?
 - *UV spectroscopy (HST); Large area surveys (single-dish radio telescopes); FUSE; GAIA*
- What is the role of the ISM in other galaxies?
 - IRAM; HST (UV spectroscopy); Chandra; **CARMA; ALMA;**
- What is the evolution of the I(G)SM over cosmic time?
 - Existing radio telescopes; HST (deep fields, absorption lines); large OIR telescopes; **JWST; ALMA; ELT**

Interstellar medium: facilities

Italics denote ongoing/rapid progress

- How does interstellar matter evolve to stars & planetary systems?
 - What is the origin and evolution of dust?
 - Spitzer; VLTi; **ALMA**; **laboratory astrophysics**
 - What is the origin and evolution of interstellar molecules?
 - *Spitzer*; *existing OIR telescopes*; *existing radio telescopes*; **JWST**; **ALMA**; **Herschel**; **ELT (spectroscopy)**; **laboratory astrophysics**; (**FIR interferometer for H₂O**)
- What is the origin and role of magnetic fields?
 - *Existing radio telescopes*; **SKA**; **ELT (polarimeters)**

Stars: facilities

- What determines the initial mass function?
 - Existing radio and OIR telescopes; Virtual observatory; numerical simulation; HST; **ALMA; JWST; ELT (extra-galactic)**
- What physical processes determine the characteristics of stars throughout their lifetimes?
 - Chandra; XMM; VLTI spectroscopy; UV spectroscopy; **COROT**
- What physical processes govern the stellar environments throughout their lifetimes?
 - HST; VLTI; VLBI; existing OIR telescopes; **ALMA; SKA; JWST; ELT; Herschel**
- What is the origin of the heavy elements and how are they recycled into the ISM?
 - *HST imaging (SN@z); JWST; ALMA; ELT (spectroscopy)*

Planets: facilities

- How common are planetary systems?
 - *Ground-based OIR telescopes*; HST; VLTI; COROT; Kepler; GAIA; (Eddington); ELT
- What are the characteristics of planetary systems?
 - *Ground-based OIR telescopes*; TPF/Darwin; ELT; SKA
- What are characteristics of planetary atmospheres & oceans?
 - HST; TPF/Darwin; ELT
- Is there extra-terrestrial life?
 - ATA; TPF/Darwin; SKA; ELT

ISM: science emphasis

Steve's picks; not WG consensus

- + Rapid progress, investment, or anticipated solutions:
 - What is the role of the ISM in other galaxies?
 - What is the evolution of the I(G)SM over cosmic time?
 - How does interstellar matter evolve to stars & planetary systems?
 - What is the origin and evolution of dust?
 - What is the origin and evolution of interstellar molecules?
- ✓ Ongoing progress
 - What are the dynamics and evolution of the ISM in the Galaxy (the life cycle)
- o Limited progress, investment, or great difficulty:
 - What is the origin and role of magnetic fields?

Stars

Steve's picks; not WG consensus

- + Rapid progress, investment, or anticipated solutions:
 - What is the origin of the heavy elements and how are they recycled into the ISM?
- ✓ Ongoing progress:
 - What physical processes determine the characteristics of stars throughout their lifetimes?
 - What physical processes govern the stellar environments throughout their lifetimes?
- o Limited progress, investment, or great difficulty:
 - What determines the initial mass function?

Planets

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