Space Physics at Princeton

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iMAP INTERSTELLAR MAPPING AND ACCELERATION PROBE

Science Opportunities for Interstellar Neutral Gas Observations with Adjustable Boresight Directions of IMAP-Lo (SH51C-3343)

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Motivation

The interstellar neutral gas (ISN) of various species and populations can be detected inside the heliosphere. *IBEX* has been observing it in an Earth's orbit in a fixed direction (90º) relative to the Sun from 2009. The fixed geometry limits the observation season for the ISN species to few months each year. *IMAP-Lo* detector onboard the *Interstellar Mapping and Acceleration Probe (IMAP)*, will have an ability to track the ISN flux in the sky throughout the entire year.

We study observation geometries for various ISN gas species and their populations as a function of ecliptic longitude during the year and a phases of solar activity.

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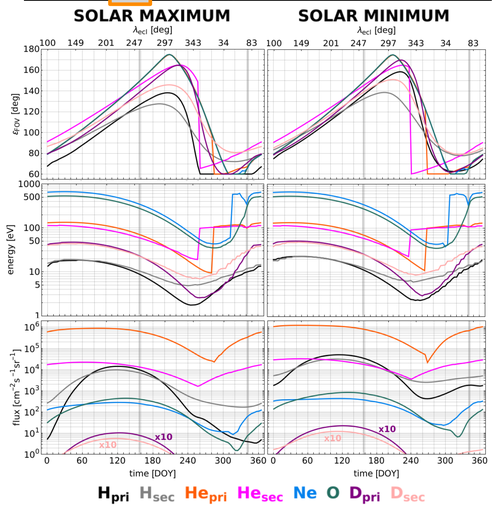
Methods

Software: numerical Warsaw Test Particle Model;
Ionization rates: observation-based, variable in time and heliographic latitude;
Radiation pressure for H and D: observation-based, variable in time;
Flow directions: based on *IBEX* measurements;
Detector: *IBEX*-type with field of view (FOV) enlarged to 9º at FWHM, collimator transmission function included;
Location: Earth's orbit around the Sun.
ε_{FOV} – elongation angle of detector observation direction (60º-180º);
DOY – day of year.

4. Tracking Maximum Flux



- Tracking of the flux peak requires a change of observation direction in a wide range along the orbit, but provides with high flux and energy. All species and populations are accessible for detection in the first 6 months of a year.

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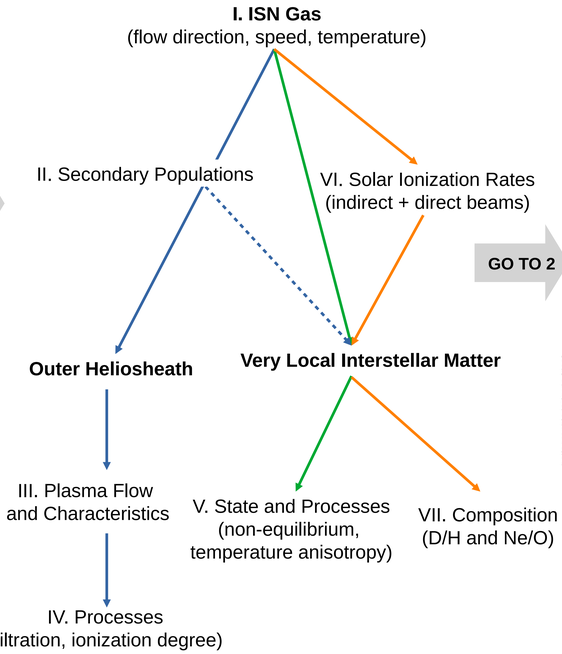
1. Hierarchy of Science Opportunities



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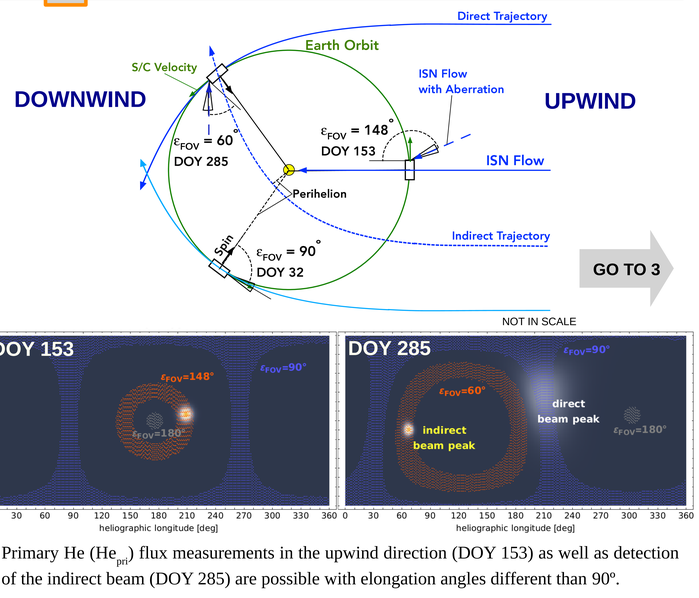
2. ISN Gas Sky-Distribution from Various Vantage Points



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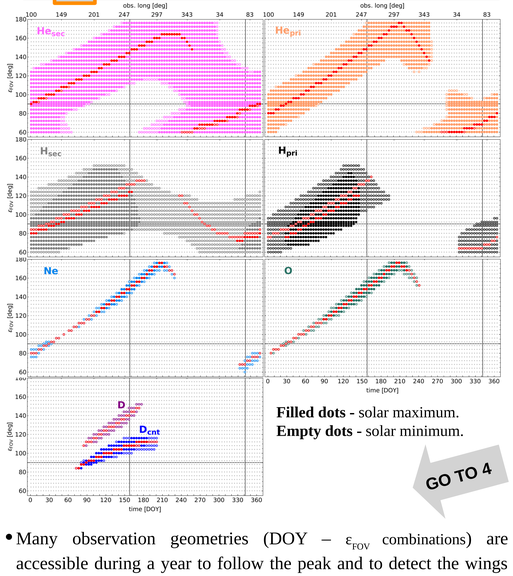
- Primary He (He_{pri}) flux measurements in the upwind direction (DOY 153) as well as detection of the indirect beam (DOY 285) are possible with elongation angles different than 90º.

3. Accessible Observation Geometries



Filled dots - solar maximum.
Empty dots - solar minimum.

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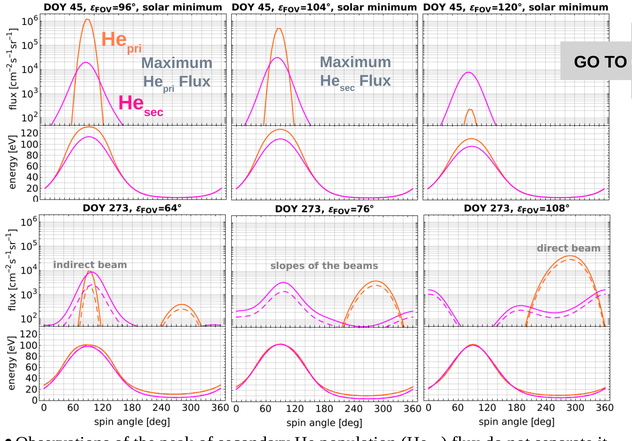
- Many observation geometries (DOY – ε_{FOV} combinations) are accessible during a year to follow the peak and to detect the wings of the flux distribution in spin angle.

5. Separation of Primary and Secondary Fluxes



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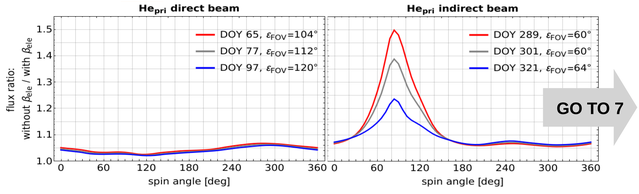
- Observations of the peak of secondary He population (He_{sec}) flux do not separate it from primary population. Observations at a direction a few degree off are necessary to fully separate the He_{sec} from significant contribution from He_{pri}.

6. Ionization Rates via Indirect Beam



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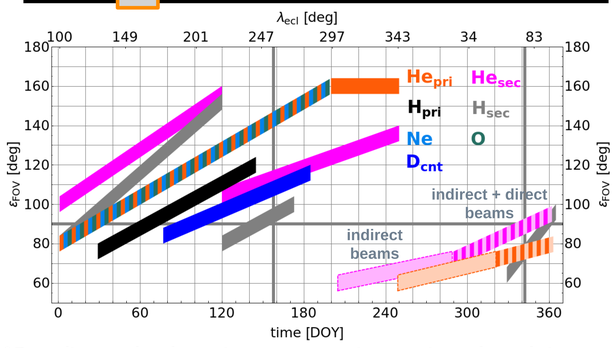
- Indirect beam of ISN gas is more attenuated by electron impact ionization (β_{ele}) than the direct beam, because the atoms passed closer the Sun, where the ionization rate is greater.

7. Multi-choice Observation Scheme



- Depending on the observation geometry various species and populations are accessible to measure. The last 6 months in a year are a period when indirect beam of ISN He is possible to detect.

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8. Conclusions

- The capability to adjust boresight direction allows for ISN gas ***observations during the entire year.***
- ***Increase of data collection*** statistics for heavy species.
- ***Observations in the upwind hemisphere*** and more precise determination of the flow parameters.
- ***Separation of secondary population*** from contribution from primary population in the measured signal of ISN He and H.
- Detection of ***indirect beam*** and ***consequent study of ionization rates***.
- ***Determination of the abundances*** of ISN gas species in the boundary region of the heliosphere enabled.

MORE

More

Sokół et al. 2019, *Science opportunities for observations of the interstellar neutral gas with adjustable boresight direction*, ApJS (also arXiv:1911.10265)

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