Ionization and Composition of Protoplanetary Disk
HST 10 in the Orion Nebula

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Instruments: NICMOS  Proprietary period: 12
Cycle 11 primary orbits: 28
Cycle 11 parallel orbits: 0

Abstract

The Orion Nebula, the closest region of massive star formation to Earth, provides a unique opportunity to study extended protoplanetary disks, or proplyds, around young stellar objects. With the search for exoplanets, including ones like Earth, in full force, it is important to understand the composition of the disks from which they can be formed. By performing spectroscopy on three different regions of the protoplanetary disk of HST 10, an average proplyd in the Orion Nebula with a distinct extended disk, we will gain insight into the composition and ionization structure of the proplyd. These factors will strongly influence the evolution and formation of the disk and infant star into a stellar system, as full or partial ionization can result in a mount in pressure that can destroy the disk. These observations will greatly contribute to isolating the conditions and compositions of an intact proplyd, which will provide a greater understanding of the conditions required for star and planet formation.
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<th>RA</th>
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<th>V</th>
<th>Configuration, mode, aperture</th>
<th>spectral elements</th>
<th>Total orbits</th>
<th>Flags</th>
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</table>

NOTE: This grand total (27) does not equal the sum of cycle 11 primary (28) and parallel (0) orbits plus cycle 12 primary (0) and parallel (0) orbits plus cycle 13 primary (0) and parallel (0) orbits on page 1.
Scientific Justification

Often, important information about the geometry and details of an object will be lost because it is too distant to resolve. However, the Orion Nebula is only 1,300 light-years away, and we have a unique opportunity to resolve protoplanetary disks around young stellar objects. These photoevaporating disks are called proplyds, and they are key in the understanding of early evolution and formation of stars and planets. Proplyds are often subjected to intense ionizing radiation from nearby hot, massive stars due to their locations in star-forming regions. The nature of this ionization is critical in the retention of protoplanetary disks, since when the disk is all or partially ionized, an excess of radiation pressure can lead to loss of material and potential destruction of the disk. We will focus our observations on HST 10, a teardrop-shaped proplyd in Orion with a large, well-defined disk which receives ionizing radiation from the nearby Trapezium stars. It is early enough in its evolution that it does not yet have a well-defined central star. With the power of the HST, we will perform spectroscopy in three distinct places within the disk, starting near the center and moving out towards the edge which should be ionized by the nearby massive stars. We will in particular look for absorption from neutral oxygen and helium (6300, 4471 Å), singly ionized sulfur and nitrogen (4069, 5755 Å), and doubly ionized oxygen (4363 Å), because these have been shown to indicate different levels of ionization within the proplyd, from neutral to strongly ionized. The relative strengths of these ionization emission spectra in the different regions of the proplyd can be spatially related on pre-existing images of HST 10 and will indicate the geometry of the ionization within the proplyd. Redshifts at this distance contribute less than an angstrom shift. The collected spectra will also give an indication as to the composition of the proplyd through the previous lines as well as IR lines of varying strengths of doubly ionized neon, chlorine, and iron (3967, 5518, and 5270 Å), and three times-ionized argon (4711 Å). It is this composition, as well as the shape and extent of ionization from the nearby stars, which will strongly influence the evolution and formation of the disk and infant star into a stellar system with possible planets. If we can use observations from this as well as future projects to isolate the conditions and compositions under which planets may form, it may be possible to predict the existence of such systems in regions for which the star formation history is known.

Description of the Observations

We will be using a total of seven different narrow filters in the infrared. Using the signal/noise calculator for these filters at http://etc.stsci.edu/etc/input/stis/spectroscopic/, we calculate a time of 4000 seconds per filter to comfortably reach a S/N of 8, and a time of 2000 seconds per filter to reach a S/N of 5. A S/N of 8 is good and reasonable for our observations because the protoplanetary disk may be thin and will have a dim spectra, and we must also account for the ambient spectrum of the dense Orion Nebula surrounding it. Performing spectroscopy in three different locations on the proplyd will require 21*4000=84000 seconds of observation time. This amounts to 27 orbits if we can observe for 52 minutes per orbit. Thus, we propose to use 28 cycles, with the extra time as a cushion for setup, calibrations,
and unexpected problems.

- **Special Requirements**
- **Coordinated Observations**
- **Justify Duplications**
- **Previous HST Programs**