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AN OBSERVATIONALIST'S VIEW OF THE FUTURE OF ISM RESEARCH

C. R. O'Dell

Department of Space Physics and Astronomy
Rice University, Houston, TX 77005, USA

RESUMEN

La búsqueda de un mejor entendimiento del Medio Interestelar requiere de progresos en modelaje, teoría y observaciones. El autor presenta un resumen de lo que los futuros instrumentos del *Telescopio Espacial Hubble* harán acerca del Medio Interestelar

ABSTRACT

The quest for better understanding of the ISM demands progress in modeling, theoretical insights, and observations. The author presents a summary of what forthcoming *HST* instrumentation will do for research on the ISM.

Key words: **ISM: GENERAL — TECHNIQUES: MISCELLANEOUS — INSTRUMENTATION: MISCELLANEOUS**

1. INTRODUCTION

Astronomical research has a long history of advancing through alternating leads between the process of observations, theoretical insights, and modeling. A good example of this is the knowledge of H II regions. These were well known since the first telescopic observations of the Orion Nebula early in the 17th century, their emission line nature was revealed in the 19th century by the spectroscopic work of William Huggins, and their forms were well documented by the photographic work of E. E. Barnard. However, it was not until the important theoretical insight about photoionization equilibrium of Strömgren (1939) that their true nature was understood. The idea of a basically spherical distribution of material around an embedded star prevailed for several decades. This dominated the way we viewed H II regions and led to addition of erroneous facets like "the filling factor" in the Orion Nebula in order to "save the model". It was not until blister models were calculated by Tenorio–Tagle (1976) that we knew the real nature of this brightest close H II region. This new understanding of M42 has altered the way that we view many H II regions to the degree that most of the optically bright H II regions are thought to be thin ionized layers on the face of giant molecular clouds. Now the cycle seems to be repeating itself with new observations of Orion at unprecedented angular and spatial resolution seeming to give new insight about this object (O'Dell 1994; O'Dell & Wen 1994).

2. NEW *HST* SCIENTIFIC INSTRUMENTS

Instruments for conducting research on objects within the subject of the ISM usually can be classified as either imaging or spectroscopy. Even during the development phase of the *Hubble Space Telescope* (*HST*) it was recognized the ISM problems would command a significant portion of the observing time, but only the imaging instruments were well suited for the task. The initial wide-field camera (WF/PC) and its successor (WFPC2) represent a good balance between angular resolution and field of view and have been used to produce many spectacular images. The lack of availability of suitable detectors meant that both of the initial spectrographs (the low resolution FOS and the high resolution GHRS) employ 512 × 1 linear detectors, so that two dimensional spectra across the face of a nebula or H II regions in a galaxy become extremely time consuming to obtain. Given the extreme oversubscription of the *HST*, this has meant that few such programs have been pursued.

[1]Guest Investigator, Space Telescope Science Institute, operated by AURA on behalf of NASA.

None of the present complement of instruments goes beyond about 1000 nm in wavelength, thus precluding study of this important wavelength region.

These limitations mean that the initial complement of Scientific Instruments (SIs) for the *HST* are far from optimum for studies of the ISM, a situation that will change dramatically after the next refurbishment mission, presently scheduled for January, 1997. At that time two of the present complement of axially mounted SIs will be removed (FOS, GHRS, and the high resolution camera FOC) and replaced with new SIs that hold enormous promise for ISM research. The two new SIs are called STIS (Space Telescope Imaging Spectrograph) and NICMOS (Near Infrared Camera and Multi-Object Spectrometer). Which SIs will be replaced is not firmly known at the time of writing this article.

3. STIS

STIS is being developed by a team lead by Bruce Woodgate of the Goddard Space Flight Center. It is primarily a long slit spectrograph of high sensitivity and photometric accuracy, although it also has direct imaging modes, providing a backup to the present WFPC2 and the FOC. It employs 4 detectors, each optimized for a particular spectral range, with the result that there is continuous spectral coverage from 115 nm through 1000 nm. In the long slit mode it can give resolutions of 500 – 1 000 and 5 000 – 10 000 in all wavelength ranges and in a short slit mode it will give resolutions of 24 000 and 100 000 shortward of 310 nm. The matchup of pixel size to telescope scale should allow diffraction limited performance into the ultraviolet where the *HST* images are smallest (about 220 nm). The detectors are all 1024×1024 pixels, so the total field of view is typically about $30''$.

4. NICMOS

NICMOS is being developed by a team lead by Rodger Thompson of the University of Arizona. It is primarily a near infrared camera, although it also has limited spectroscopic capabilities. It will be the first *HST* SI to cover the near infrared and employs three different HgCdTe 256×256 pixel arrays, each sensitive from 800 – 2 500 nm. Since each detector is fed by a separate optical train, NICMOS can simultaneously record three separate fields of view. The fields of view for each detector system is $11'' \times 11''$, $19.2'' \times 19.2''$, $51.2'' \times 51.2''$ and the filter set is selected so that longer wavelength images go onto the larger fields of view. This matching gives diffraction limited performance at 1000 and 1750 nm for the two more narrow field systems. A set of grisms allow low resolution objective spectroscopy over the full wavelength range. The mid-range camera system also has a coronographic mode with an effective occulting disk size of $0.3''$.

5. OBSERVATIONS

Since both instruments are being developed by teams of scientists, there will be certain programs and targets restricted to access by these persons. These programs will be published openly as was done with earlier Guaranteed Time Observer programs for the initial phase of use of the *HST*. The instruments will be available to the General Observers of *HST* immediately after their commissioning period has been successfully completed. This means that we can expect the next call for proposals to be issued about January, 1996 for their use; although the details of such a schedule are not yet announced and subject to revision. What is invariant is that these will be very powerful instruments for the study of the ISM in our Galaxy and others. These are the types of instruments that we have come to consider the standards for research with large ground based telescopes and with them the *HST* will attain a flexibility for our type of observations that it has not previously enjoyed.

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