



# INFORMATION BULLETIN D'INFORMATION

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## A Public Archive for CFHT Data

The observations obtained at CFHT are in many respects a unique and irreplaceable scientific resource. They are also expensive both in terms of direct costs (~\$2000 per usable hour) and in the time astronomers must spend at the telescope. It therefore makes eminent good sense to preserve these data for future use by researchers throughout the scientific community. Thanks to recent advances in computing, data storage, and high-speed communications, this worthwhile goal is now also a practical possibility. With these considerations in mind, CFHT has decided to establish a public archive of data obtained at the telescope which will be available to all qualified researchers after a proprietary period of two years. Archives such as this are already common for space observations, but for ground-based astronomy, we are among the pioneers. As in any pioneering effort, there will almost certainly be difficulties along the way, but in view of the great potential benefits, we have decided to go ahead and face up to the challenges as they arise.

The project was initiated officially in June 1987 when the Board of Directors adopted a public domain policy which stated that "data will be available for scientific analysis by people other than the original investigator(s) after two years from the time the data were acquired". At the same time, the Board directed the Corporation to develop an implementation plan based on this general policy. The Scientific Advisory Council discussed the matter in November 1987 and concluded that there were a number of practical issues that still needed study before a detailed implementation plan could be put forward. This task was assigned to a working group comprising Dennis Crabtree and Daniel Durand of the Canadian Astronomy Data Centre (based at DAO in Victoria) and CFHT Resident Astronomer Carol Christian.

The working group presented its report, *CFHT Digital Data Archive: Proposal for Implementation*, to the SAC at its meeting in May. After clarifying a few points, SAC drafted a recommendation to the Board that the proposed implementation plan be adopted. At this time I would like to thank the working group on behalf of the CFHT community for a job well done. The Board gave its final approval at its meeting in June.

### Archive Policy

The policy governing the Data Archive and public access to it is as follows.

- The data will be placed in the archive shortly after they are obtained—probably at the end of each semester.
- The proprietary period will be two years beginning at the end of the semester in which the data are obtained. During the proprietary period, the original principal investigator(s) will have exclusive rights to the data for scientific use.
- At the end of the proprietary period, the data will be available to any qualified researcher through access to the archive.
- It is expected that the two-year proprietary period will apply to almost all archive data. However, it is recognized that in a small number of cases a longer period may be justified. There are two mechanisms for obtaining an extended proprietary period. If it is clear from the outset that two years is not adequate, a request can be made for an extension at the time of the original proposal. Section #11 has been added to the Observing Time Request form for this purpose. If the TAC feels that the extension is justified, it will be granted with the observing time. It may also happen that circumstances arise during the original proprietary period which justify an extension. In such cases, the P.I. can request that TAC prolong the proprietary period. Such requests must be carefully justified and must be received by TAC no later than the semester preceding the scheduled release of the data—i.e. two years after the original proposal.

### Implementation and Timing

In the implementation of the archive program, we will be guided by two basic principles. The first is that insofar as possible the archiving of the data must be automatic and transparent to the observer. In this regard it is fortunate that we are also in the process of upgrading our data acquisition system (see Jon Brewster's article later in this Information Bulletin). The software for the HP 9000 has been designed from the outset with the archiving requirement in mind. The FITS header accompanying each block of data (CCD image, Reticon spectrum, etc.) will contain all the information that the archival researcher will need (date/time, observer, program, object,

instrument parameters, environmental data, etc.). All of this will be recorded automatically; the observer will be prompted to add comments. The data will be written to the archive medium automatically and almost immediately. Several techniques are being considered. One possibility is to use VHS magnetic tape (2.5 Gbyte/tape) at the summit. Alternatively, if a high-speed data link becomes available soon, we could transfer the data to Waimea and record it there either on VHS or perhaps optical disk. Once or twice per semester, the archive tapes (optical disks) will be sent to the Canadian Astronomy Data Centre. At CADC, the tapes will be scanned and the FITS headers checked for completeness and consistency. After any necessary modifications, the header information will be incorporated into the CFHT Catalog. The corresponding data will be copied into the CFHT Archive. At the end of each semester, the portion of the Catalog and Archive which is in the public domain will be expanded to include the data for which the proprietary period has just expired. Access to the Catalog will be primarily by remote log-in with requests for data being transmitted in the same way. It is possible that small data sets can be returned electronically but most request will be handled by mail. CADC's support of the CFHT Archive will be an extension of its primary role, as an archive centre for space data (IUE, HST, AXAF, etc.). The necessary procedures and user interface are already

being developed and tested using existing space data. If there are other institutions within the CFHT community which are capable of supporting the Archive and willing to do so, then the data can be made available to them as well.

While the basic policy on public access applies to *all* data, the extent and timing of its implementation will be determined by practical considerations. This is the second principle which will guide us. The current plan is to implement the program only for data obtained with the second-generation data acquisition system (the HP 9000). In this way we can ensure a high degree of uniformity and completeness, which is essential if the archive is to be useful. Barring unforeseen difficulties, we should be able to start archiving all data obtained with CFHT's CCD's (imaging plus spectrographs, MOS/PUMA, Herzberg, UV Prime, and coudé) in first semester 1989. Insofar as is practicable we will also include visitor instruments which use CFHT's CCD's. The other CFHT instruments (Reticon, FTS, Fabry Péro) will follow later. By first semester 1990, it is expected that all digital data obtained with commissioned CFHT instruments will be part of the archive program.

Comments from the CFHT user community on the archive program should be addressed to the Director and are most welcome.

*R. McLaren*

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## The Abundance of Deuterium in the Solar System

Deuterium is destroyed in stars. The D/H ratio in the interstellar medium has therefore decreased since the origin of the Universe. Measurements of this ratio in the solar system are interesting as they can, in principle, provide a lower limit to the primordial abundance of deuterium. This is probably true in the case of the giant planets which have little evolved since their formation. In the case of the terrestrial planets which have lost their primordial atmosphere, measurements of the deuterium abundances have another interest: they can provide information on the evolution of the planets themselves.

There are several ways to measure the D/H ratio in a planet. Possible approaches are direct in-situ mass-spectrometer measurements or the study of D emission lines in the ultraviolet made from Earth-orbit satellites or from a spacecraft. The D/H ratio can also be obtained spectroscopically from the intensity of lines of HD compared with  $H_2$  ( $D/H = \frac{1}{2} \times [HD]/[H_2]$ ), and, more indirectly, from absorptions of other deuterated species such as deuterated methane, ammonia or water (with methane, for example:  $D/H = \frac{1}{4} f \times [CH_3D]/[CH_4]$ , where  $f$ , the fractionation factor, is always higher than 1 and depends on the temperature at which methane equilibrates with the surrounding atmosphere).

However, measurements of the abundance of deuterium in the solar system have not been easy to obtain. In-situ measurements have been made for Venus using two different experiments on-board the Pioneer Venus orbiter and probe. Both measurements appear consistent with a D/H ratio 100 times higher than on Earth, but it would be very important to get an independent confirmation of such a high value. Although several spacecraft have visited Mars, deuterium was never detected. Concerning the giant planets, spectroscopic measurements have been made from the

Earth and with the Voyager spacecraft for Jupiter and Saturn. The D/H ratio was measured in the atmospheric hydrogen and in methane. The only information on the deuterium abundance on Uranus and Neptune came from measurements of the intensities of lines of HD in the visible. However, these lines are badly blended with lines of methane, which prevents one from obtaining good estimates of the abundance of deuterated hydrogen.

A few years ago, we started an observing program dedicated to measurements of the abundance of deuterium in planets in which this isotope had never been detected, or for which the uncertainties in the existing measurements were still too large.

We had detected in the laboratory, near  $1.6\mu m$ , a band of  $CH_3D$  which had never been seen before, and made an extensive study of this band, using high resolution FTS in various laboratories (Meudon, Kitt Peak), because this band might be of interest for the study of deuterium in the coldest planets. We started an observing program with this goal in mind, first at Kitt Peak, with the FTS at the 4-m telescope, and then at CFH as soon as the Cassegrain FTS became operational. At Kitt Peak we detected  $CH_3D$  in Uranus and Titan, and, at CFH,  $CH_3D$  in Neptune.

### 1. Venus and Mars

Our search for deuterated species in the terrestrial planets was made at CFH at longer wavelength. We looked for DCI on Venus, HCl being present in the venusian atmosphere, and for deuterated water (HDO) on Mars. These minor constituents can be more easily detected in the regions of the strongest bands. The fundamental bands are located in the thermal infrared. The 1-0 vibration-rotation