A Search for Interstellar Be II λ 3130: CASPEC Shakes Hands With IUE and GHRS

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The wavelength region near the atmospheric high-frequency cut-off is still a considerable challenge for high-resolution spectroscopy. The sensitivity of both IUE and GHRS on HST drops steeply at wavelengths where atmospheric absorption still is a substantial handicap for ground-based observers. The situation is even worse if signal-to-noise ratios considerably in excess of 100 are also required and which are not within easy reach of either IUE or GHRS.

Scientific Background

One of the most interesting spectral features in this domain is the strongest line of Be II at 3130.4 Å (in most of the relevant astrophysical environments, the singly ionized atom will by far be the dominant ionic species). With atomic number 4, this element is just at the limit where some non-standard big-bang model calculations predict traces of primordial abundances (e.g., Boyd, R.N., Kajino, T.: 1989, *Ap. J. (Letters)* **336**, L55). The main source of beryllium is probably the spallation by cosmic rays of heavier nuclei in the interstellar medium. Knowledge of the efficiency of the spallation process and the concomitant depletion onto dust grains is very essential for assessing the primordial abundance of lithium, the element which is the most important cosmological diagnostic. In stars, beryllium is quickly destroyed at temperatures above about 3.5×10^6 K. It can, therefore, be expected to be seen only in cool stars where, so far, crowding in the 313-mm region has permitted only upper limits to be determined (e.g., Ryan, S.G., Bessel, M.S., Sutherland, R.S., Norris, J.E.: 1990, *Astrophys. J. (Letters)* **348**, L57; Rebolo, R., Molaro, P., Abia, C., Beckman, J.E.: 1988, *Astron. Astrophys.* **193**, 193).

Also in the interstellar medium, only upper limits have so far been obtained (Boesgaard, A.M.: 1985, *P.A.S.P.* **97**, 37). They suggest that from space the best strategy would presently be to go to fainter sources with large column densities which can be detected even at relatively low S/N. By contrast, there seems to be a niche for ground-based efforts if a large light-collecting area is combined with a low-noise detector. The best upper limits on the equivalent width of interstellar beryllium lines (down to 0.23 mÅ) have, in fact, resulted from observations from the ground (Boesgaard, op. cit.).

Observations

For the detection of isolated spectral features, a spectral resolution, $\Delta\lambda$, roughly equal to the line width is close to optimum. This would have made the CES the instrument of choice. However, towards the UV, the high-efficiency multi-layer coatings of the optical surfaces of the CES have an extremely steep fall off in throughput which sets in at wavelengths noticeably longer than 3130 Å. Therefore, our only chance was to submit an application for observing time with CASPEC. We were allocated two nights in May 1990.

We used CASPEC with the 31.6 lines/mm echelle grating (which has twice the efficiency of the 51.6 lines/mm grating in the UV), the Long Camera (which provides a better sampling, i.e. reduces the effect of small-scale detector blemishes and facilitates the definition of order and inter-order space), and a coated (for higher UV response) GEC CCD (ESO No. 7) which has 576×385 pixels of 22×22 μm. With this configuration, we

First Announcement of the 3rd ESO/ST-ECF

Data Analysis Workshop

ESO, Karl-Schwarzschild-Straße 2
D-8046 Garching, FRG

April 22–24, 1991

The aim of the Workshop is to provide a forum for discussions of astronomical software techniques and algorithms. It is held annually during the spring (April/May) and centres on a different astronomical area each time. Due to available space, participation will be limited to 80 people. At the last Workshop several people could not be accommodated and we therefore recommend that you send in the corresponding participation and accommodation forms well before the deadline.

The topic for the 1991 Data Analysis Workshop will be analysis of direct imaging data. The scientific section of the meeting will consist of three sessions each starting with a main talk followed by presentation of papers of 5–10 minutes duration. The last day is reserved for general user meetings for MIDAS and ST-ECF.

The tentative agenda is:

Analysis of Direct Imaging Data

April 22: 14.00–18.00: Digital Filters
April 23: 09.00–12.30: Image Restoration
14.00–17.00: Decomposition techniques
17.00–18.00: European FITS Committee
April 24: 09.00–12.00: MIDAS users' meeting
12.00–13.00: European FITS Committee
14.00–17.30: ST-ECF users' meeting

Contributions on algorithms and techniques, e.g. removal of cosmic ray events on CCD's, digital transformations, deconvolution, decomposition of images and fitting techniques are especially welcome. We encourage people to present their work in these areas even if it is only ideas. After each introductory talk, we will have a more informal discussion where such contributions can be made. We also plan to have a poster session where people can present short contributions. Proceedings of the scientific sessions will be published.

The scientific organizing committee includes: P. Grosbøl (Chairman), L.B. Lucy, D. Baade, P. Benvenuti, S. D'Odorico, R.H. Warmels

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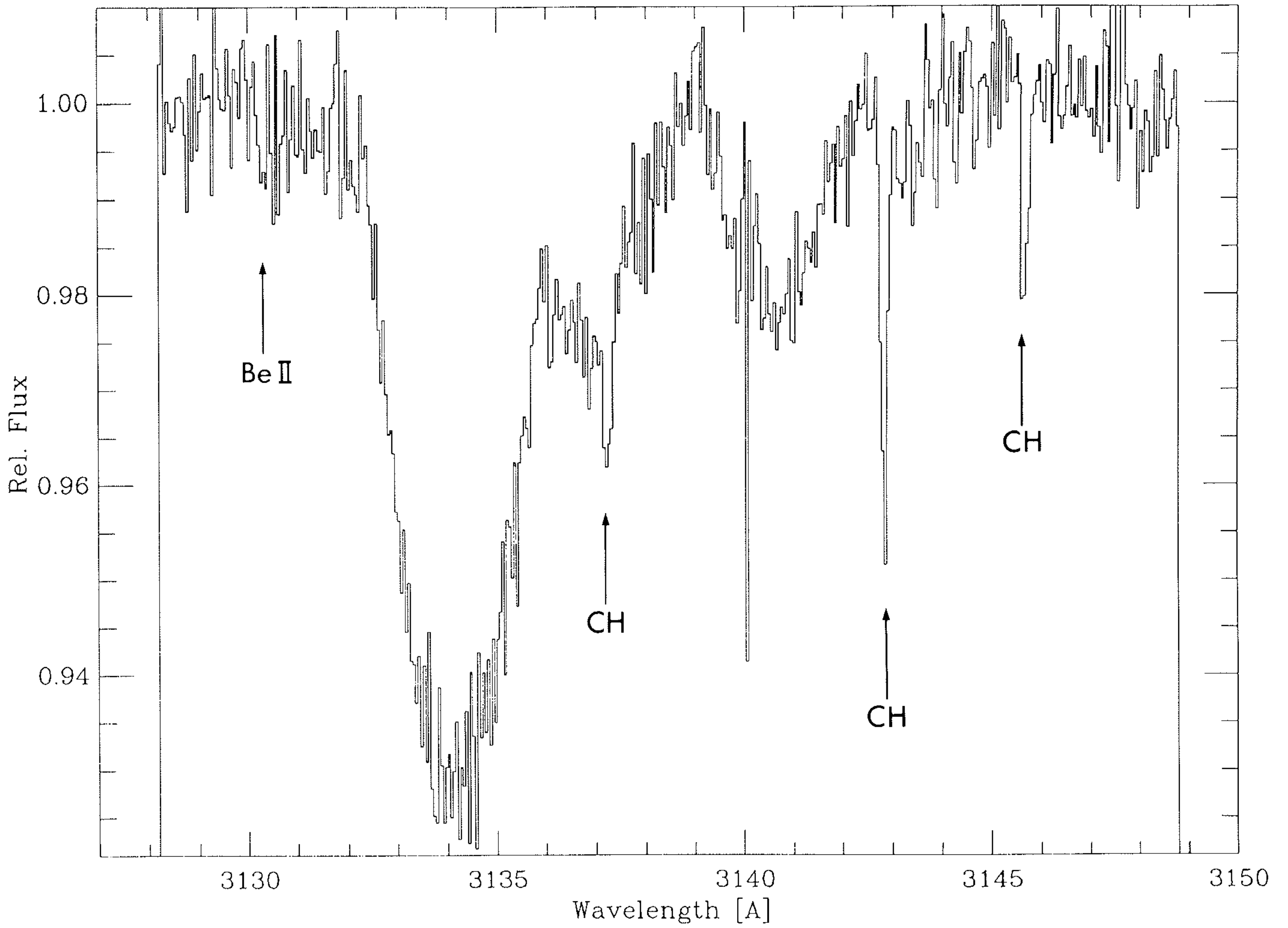

Figure 1: *Normalized spectrum (sum of four exposures for a total of 165 minutes; step size 0.05 Å) of ζ Oph in order 181 of the 31.6 lines/mm echelle grating of CASPEC. Absorption lines of interstellar CH at 3137.5, 3143.2, and 3146.0 Å are marked. The arrow points to the expected position of the Be II λ 3130 line that had been searched for. The spikes at 3140 Å are caused by a detector blemish. Broad absorption features should be of stellar origin; the strongest one is due to O II λ* 3134.8.

could observe orders Nos. 164–188, i.e. approximately the range from 3000 to 3500 Å, and there was a small overlap in wavelength between neighbouring orders.

We basically faced two technical problems. The first was (as was known in advance) that the light from the internal calibration lamps (flatfield and comparison spectrum) normally goes through a non-quartz prism which, of course, at our wavelength had to be bypassed. The installation of a quartz prism is now being considered, but has not yet finally been decided, so that observations at these short wavelengths cannot presently be offered to Visiting Astronomers. The other problem was the identification of "our" order (No. 181) which was so far beyond the range mapped in ESO's standard atlas of the thorium spectrum (S. D'Odorico, M. Ghigo, D. Ponz: 1987, *ESO Scient. Report* No. 6) that we had to approach it via two intermediate settings. (Meanwhile, we have prepared a simple extension of the atlas for the 31.6 lines/mm echelle grating towards 3000 Å which is now available also at La Silla.) With the help of Alain Gilliotte and Philippe Carton, both problems were efficiently solved.

For the flatfielding we tried an entirely new approach because at the short wavelengths fringing in the CCD should not be a problem. Therefore we turned the echelle grating to a position corresponding to about 4000 Å where the transmission of the prism is still good. We then took a flatfield exposure with the slit expanded close to its maximum physical length. This had the effect that anywhere on the CCD a large number (~20) of echelle orders were superimposed on one another so that the CCD was relatively uniformly illuminated. As far as we can tell from our preliminary analysis, this method is quite useful for the correction of detector blemishes such as column-to-column offsets which cannot be removed with standard flatfield exposures. Obviously, it should be generally valid for echelle observations, irrespective of the instrument or the wavelength range.

Although we have not tried it, it appears to us from this experiment that flatfield or trailed stellar exposures with the slit length chosen such that neighbouring orders just touch one another (and taken at the correct grating angle) could provide a useful basis for modelling the echelle blaze function.

Results

Unfortunately, we cannot report any new scientific results. Shortly after we had geared up the instrument on the first night, clouds moved in which were even worse on our second night and thus reminded us strongly of additional reasons why there are space observatories. Therefore we had to concentrate our observations mainly on the bright (m_v = 2.6 mag) O-star ζ Oph. Because of the very steep decline of the overall throughput, orders 165–177 were at least partly saturated while orders above No. 184 (3075 Å) were severely underexposed. In Figure 1, we show for order No. 181 the sum of four spectra with a total exposure time of 165 minutes (the last third of which was noticeably compromised by clouds). The signal-to-noise ratio per spectral resolution element (0.1 Å or ~3 pixels), was slightly better than 300. For the centre of this order we estimate an overall efficiency (incl. atmospheric extinction) of roughly 0.03 %, down by nearly two orders of magnitude from the efficiency measured with CCD No. 8 at 4000 Å (Pasquini, L., D'Odorico, S.: 1989, CASPEC, *ESO Oper. Man.* No. 2).

In Figure 1, the interstellar CH lines at 3137.5, 3143.2, and 3146.0 Å with equivalent widths of about 3.7, 7.0, and 4.0 mÅ, respectively, are easily seen. But there is no feature in excess of 1 mÅ at 3130.4 Å. This value corresponds to the strongest feature within 0.2 Å of the expected position of BeII whereas the signal-to-noise ratio suggests a formal upper limit of 0.3 mÅ. Impressive though these numbers may be, they are only about the same as the ones inferred by York and Snow (1982, *Astrophys. J.* **255,** 524) from their observations with the *Copernicus* satellite.

In the final analysis, our experiment was only a successful and very promising feasibility study (which also included the reduction of our data with the echelle package in MIDAS). Nevertheless, we believe that it is perhaps worth reporting it to the readers of the *Messenger*, and we certainly feel encouraged to make another attempt.

We thank Fons Maaswinkel and Bernard Delabre for their expert advice on the choice of instruments and instrument modes and Alain Gilliotte and Philippe Carton for their competent and tireless efforts to get CASPEC properly set up.

EMMI, the ESO Multi-Mode Instrument, Successfully Installed at the NTT

S. D'ODORICO, ESO

The EMMI Project

In November 1985, a conceptual proposal for a spectrograph for the 3.5-m New Technology Telescope was presented at the 16th meeting of the ESO Scientific Technical Committee. The initial concept had been put forward the year before by J.L. Tanné and the author and later modified and improved by Hans Dekker; Bernard Delabre was responsible for the optical design and Heinz Kotzlowski for the mechanical layout.

The execution of the project started at

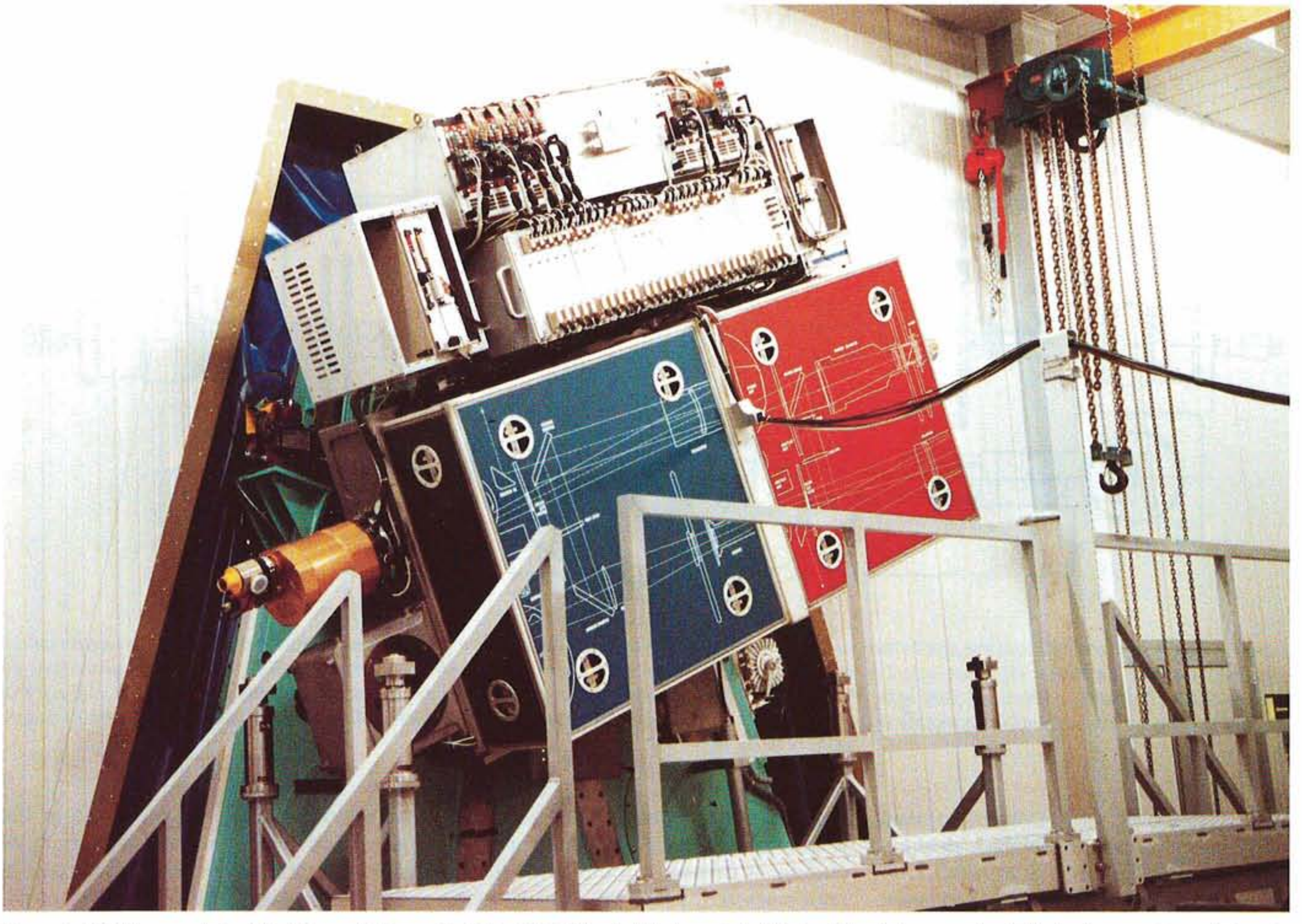

Figure 1: *EMMI mounted at the Nasmyth focus B of the NTT. The light-blue painted fork of the telescope is visible in the aperture of the air-conditioned instrument room. The adaptor/rotator is hidden by EMMI and its electronics. The colours of the panels of the cover identify the blue and red channels and show the optical path of the light in the instrument. The service platform in the forefront is also used to support the instrument when it is dismounted from the adaptor.*