NEW EXPERIMENTAL POSSIBILITIES AND FUTURE PROSPECTS FOR 1-5μm INFRARED SPECTROSCOPY OF INTERSTELLAR MOLECULES

Donald N. B. Hall
Kitt Peak National Observatory*

During the past week we have heard a considerable number of papers dealing with spectroscopic observations in the 1-5μm region of the infrared. I predict that as instruments and detectors continue to improve, such observations will play a major role in the study of interstellar molecules in both molecular clouds and circumstellar clouds around evolved stars. Fourier Transform spectrometers and Fabry Perot interferometers have already yielded spectra of such sources with spectral resolution and radial velocity precision fully comparable to millimeter wave observations. The critical need is to improve the limiting magnitude of such observations by 3-5 stellar magnitudes so that one can study large numbers of sources rather than the few brightest in each class.

Rapid advances in the technology of infrared self-scanned array detectors hold promise of such improvements. In particular, 32 x 32 pixel InSb Charge Injection Devices are now available commercially and, even with present dark current and read noise, will provide a substantial improvement in the 3-5μm range. There is an excellent chance that further developments will extend this down to 1.5μm or even 1.0μm. I expect that these detectors will be used with either two or three etalon Fabry Perot interferometers (for studies of extended emission line sources) or an echelle spectrograph in series with some form of interferometer (for studies of point sources and the interstellar material seen in absorption against them). In either case the entire instrument would be cooled to cryogenic temperatures and used with a low background, infrared optimized telescope.

If this can all be realized then the improvement in observational capability is enormous. At 4.6μm one would be able to observe pre-main sequence objects such as the Becklin Neugebauer source and evolved sources such as α Orionis or IRC+10°216 anywhere in the galaxy.

*Operated by the Association of Universities for Research in Astronomy Inc., under contract with the National Science Foundation.

B. H. Andrew (ed.), Interstellar Molecules, 631–632.

Similarly one would observe a number of sources embedded in nearby molecular clouds such as OMC 1 and thus probe the kinematics and physical conditions in the intervening cloud material. Such observations are crucial to our understanding of both pre and post main sequence evolution and also of molecular clouds and circumstellar shells.

DISCUSSION FOLLOWING HALL

Bok: Areal devices (like the Charge Coupled Device) provide great opportunities for 1 to 3 μm observations of globules with diameters of 3' to 5' and of sections of larger molecular clouds. Using the CCD at 1.2 μ at Cerro Tololo Inter-American Observatory, we recorded in 20 minutes with the 36-inch reflector several stars that could not be seen on a 200-minute hypersensitized IV N photograph taken at the prime focus of the 4-meter reflector. With the proper areal receivers operating at 1 to 3 μm and covering areas of 3' to 5' in the sky, one should be able to obtain a complete census of the distribution of dust (density gradient) inside a globule, and one should moreover detect any imbedded objects or concentrations. Such observations can readily penetrate globules with central values of A_V up to 30 and 40 magnitudes! The near-infrared observers should be able to obtain without special effort pictures of distributions comparable in quality to photographs of the stars in globular clusters. Such researches can be done from earth (or high-flying airplanes) well before the Space Telescope goes into full operation. Data of this sort should prove invaluable to radio and far-infrared astronomers engaged upon the study of molecular clouds.

Chaffee: What read-out noise do you think will be achieved with the IR CID's that you mentioned?

Hall: Elements in a prototype linear InSb CID have been operated under laboratory conditions with 50 electron read-noise; reduction to a figure of 20 electrons seems possible. In the two dimensional arrays reduction by a further factor ∿5 may be feasible using multiple nondestructive reads, as is now done with Si CID's.

Gillespie: It may be of interest to the radio astronomers to know that the array receivers are viable in the 200 to 300 GHz region using an InSb array of the type proposed by Phillips and myself recently.