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# DENIS

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**Abstract**

The DENIS survey will survey the southern sky in the near-IR J (1.2 micron) and K (2.2 microns) bands at 3" resolution and to limiting magnitudes in J and K of respectively 16 and 14.5 (1mJy in both cases), and at 1" resolution in the red I band (0.9 microns). Astrophysical motivation is provided by basic problems concerning structure and evolution of galaxies, of types ranging from our own to active galaxies, and concerning specific stellar populations including stars with low temperature photospheres, those still embedded in their protostellar envelopes, and those currently losing mass on the AGB.

## 27.1 Scientific objectives

The release of large 2D detector arrays sensitive in the near infrared provides the first opportunity to undertake a deep survey of the sky in the non-thermal infrared range (1 to 2.5 microns). This underexplored spectral range will provide crucial insights into fundamental problems in stellar and galactic astrophysics. Theere is no recent all-sky atlas of data between the visible and the IRAS 12 microns band. The 25 year-old IRC catalog remains the state of the art effort in the near IR despite its limitations. Our objective is to carr y a 3 colour (IJK) survey of the complete southern sky, improving on the pioneering IRC sensitivity by 4 orders of magnitude and improving on its spatial resolution by a factor of 20.



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There are two main motivations for a deep near IR sky survey: the near IR brightness is the best tracer of mass in stellar form, and the interstellar extinction is reduced by a factor of 10 with respect to the visible V band. It is therefore the most apropriate range for descriptions of galactic structure and of the local structure of the universe.

A basic astrophysical problem involves understanding the structure and the evolution of galaxies through the physical properties of their stellar populations. The bulk of the known mass of an evolved galaxy is in the form of stars that predominantly radiate in the micron ranghe because of their low effective temperature (red dwarfs and subdwarfs). Our knowledge of the universe derived from optical images is biased towards blue populations of stars and galaxies. It is in addition sewverley limited by extinction.

The stellar luminosity function is observationnaly poorly determined at the low mass end, and is needed to determine the contribution of low mass stars to the missing mass in our galaxy, locally, and globally. The near IR is ideally suited to study the space density of such stars. The search for stars with even lower masses, brown dwarfs, is an especially important challenge. Various arguments imply that the number of brown dwarfs detectable by DENIS may be as high as $10^5$, but confusion will render it difficult to isolate them from the few $10^7$ stars expected in the survey. Modelling suggests that the number of brown dwarfs that may be identified as such on the basis of their colours (effective temperatures less than 2000 K) is at most $10^4$. The positive identification of even a few brown dwarfs would however be a major breakthrough.

DENIS observations of low mass protostars in molecular clouds will result in improved knowledge of the initial mass function and of the efficiency of star formation in these clouds. At the high luminosity end of the stellar distribution, DENIS will detect all AGB stars in the magellanic clouds, allowing for the first time studies of a large sample of such objects at a well known distance.

Extragalactic research will also benefit from DENIS. It will provide a consistent sensus of galaxies in the local universe ($z<0.1$, which is needed to normalize the deeper counts which are becoming available. Since it will be largely free of galactic extinction problems, the galaxy catalog resulting from the survey will be a basic tool for studies of the large scale structure of the local universe.

## 27.2 The DENIS project

The DENIS objective is to survey the entire ESO-accessible sky in two near IR bands (J at 1.25 micron, and K at 2.2 micron) to a sensitivity limit of 1 mJy ($m_K$=14.5 and $m_J$=16), with a spatial resolution of 3 arcseconds, and in one red band (I at 0.9 micron) with a one arcsecond resolution. We use the existing ESO 1-metre telescope equipped with a dedicated camera. The camera is equpped with two NICMOS-3 arrays (256x256) for the J and K channels, and with one CCD (1024x1024) for the I channel. The first test data have been obtained at the telescope in december 1993, and show the sensitivity is nominal. Commissioning of the instrument and its software is proceeding smoothly and we expect the first survey observations to take place in july 1994.

The processing of the huge amount of data (a few terabytes) is a major concern. The project is aware that the data reduction effort requires resources similar to those required by the instrument building and observing efforts. The expected number of sources in the new survey is a few $10^7$, two orders of magnitude more than the number of sources in the IRAS Point Source Catalog. Our goal is to provide the astronomical community with the first comprehensive star and galaxy catalogs in this range of wavelengths, and with a complete digitized infrared map of the sky. These will be produced and distributed through two data analysis centers located in Paris and Leiden.

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