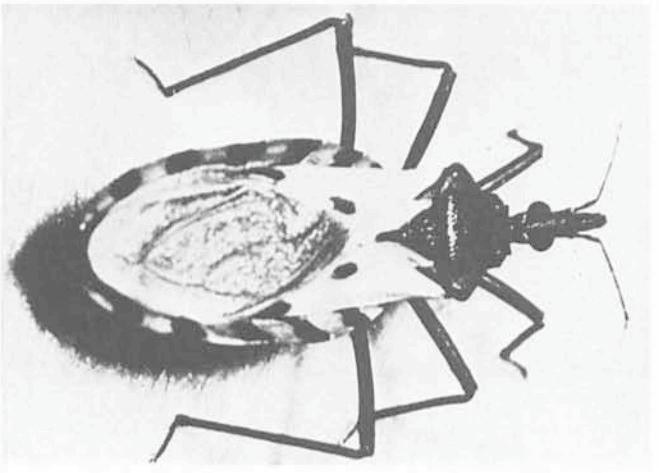

One of the vinchucas that were sent to Europe for a test some years ago. Photographed by Dr. G. Schaub of the Zoological Institute of the Freiburg University (FRG).

mestic, which can be the source of infection of the domestic or wild vinchucas.

Does any medical treatment exist for the Chagas disease? Yes. At present two types of drugs exist, Nifurtimox and Bensonidazol, both of proven efficiency.

What is the situation at La Silla? In this area the wild species *Triatoma spinolai* exists which, being attracted by the odor of humans, may bite them, especially during sleep.

The risk of infection for people is low, because only a very small percentage of infected vinchucas (6.5%) have been found, and moreover it is necessary that they defecate at the moment of biting.

What precautions can be taken? Use of protective screens against insects in the windows of the dormitories.

The ESO Administration is putting into practice a series of technical measures to control the vinchuca problem. In case a person is bitten, the appropriate blood test will be arranged. So far these tests have always had a negative result.

Star Formation in Bok Globules

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Introduction

Among the many dark clouds seen projected against the luminous band of the Milky Way are a number of small, isolated compact clouds, which often exhibit a large degree of regularity. These objects are today known as Bok globules, after the Dutch-American astronomer Bart Bok, who more than 30 years ago singled out the globules as a group of special interest among the dark clouds.

Bok globules usually have angular sizes of from a few arcminutes to about 20 arcminutes, with real sizes of typically 0.15 to 0.8 parsecs. It is generally not so easy to estimate the distance, and thus the dimensions, of a given globule. Most known globules are closer than 500 pc, since they normally are found by their obscuring effects, and more distant globules become less conspicuous because of foreground stars. A nearby, compact Bok globule is indeed a spectacular sight; when William Herschel for the first time saw a globule in his telescope, he exclaimed: "Mein Gott, da ist ein Loch im Himmel."

For many years the main tool to study globules were counts of background stars seen through the outer parts of the globules. When carefully and correctly executed, star counts can provide much valuable information; but with the advent of molecular radio astronomy it has now become possible to obtain precise data on masses, temperatures and composition of the globules. Typical globule masses are between 15 $M_\odot$ and 60 $M_\odot$, and temperatures are around 10 K to 20 K. The interior of such a small, cold cloud is well protected against the more energetic radiation from stars, and so various atoms can combine to molecules, mainly of hydrogen, with important additions of carbon oxide, formaldehyde and many more exotic molecules.

Bok's conjecture in singling out the globules as a group was that, if stars (radius $\sim 10^{11}$ cm, density ~ 1 g/cm^3) form out of denser regions in the interstellar medium (radius $\sim 10^{19}$ cm, density $\sim 10^{-22}$ g/cm^3), then intermediate stages might be seen, representing proto-proto stars.

Subsequent observations have clearly shown that the main regions of star formation are not globules, but giant molecular clouds, in which thousands of stars can form. Although globules thus are no longer necessary to understand the bulk of star formation in our galaxy, it is no less likely that a globule can form one or a few stars. The problem with this idea is just that no newborn stars had been found in association with a *bona fide* Bok globule.

The Globules in the Gum Nebula

This situation has changed with the recent discovery of a large complex of globules in the Gum Nebula. The Gum Nebula is a huge, faintly luminous H II region spread over more than 30 degrees of the southern sky. At a distance of roughly 450 pc this corresponds to a radius of about 125 pc, making the Gum Nebula one of the largest structures known in our galaxy. Near its center are several objects which together produce the ultraviolet radiation that ionizes the gas in the nebula. Among these are Zeta Puppis, an extremely luminous O star with a mass of about 100$_\odot$, Gamma Velorum, which is a massive binary system consisting of a Wolf-Rayet and an O component, as well as the Vela pulsar, a neutron star left over from a supernova explosion 10,000–20,000 years ago.

Pointing towards these objects are about 40 "windswept" or "cometary" globules, with sharp edges towards the center of the Gum Nebula, and several parsecs long, faintly luminous tails stretching in the opposite direction. This appearance can be understood as the eroding effect of the ultraviolet radiation from the luminous central stars, causing the globules to slowly evaporate and carrying material away from the dense globule heads. In this hostile environment most globules will be destroyed in a few million years. But this is long enough that stars can form in the denser globules.

Bernes 135

Associated with one spectacular globule, CG 1, is a star, numbered 135 in a catalogue of nebulous stars by Bernes (Fig. 1). The diameter of CG 1 is 0.3 pc and its total length is 3.2 pc, and the mass of its dense head is probably of the order

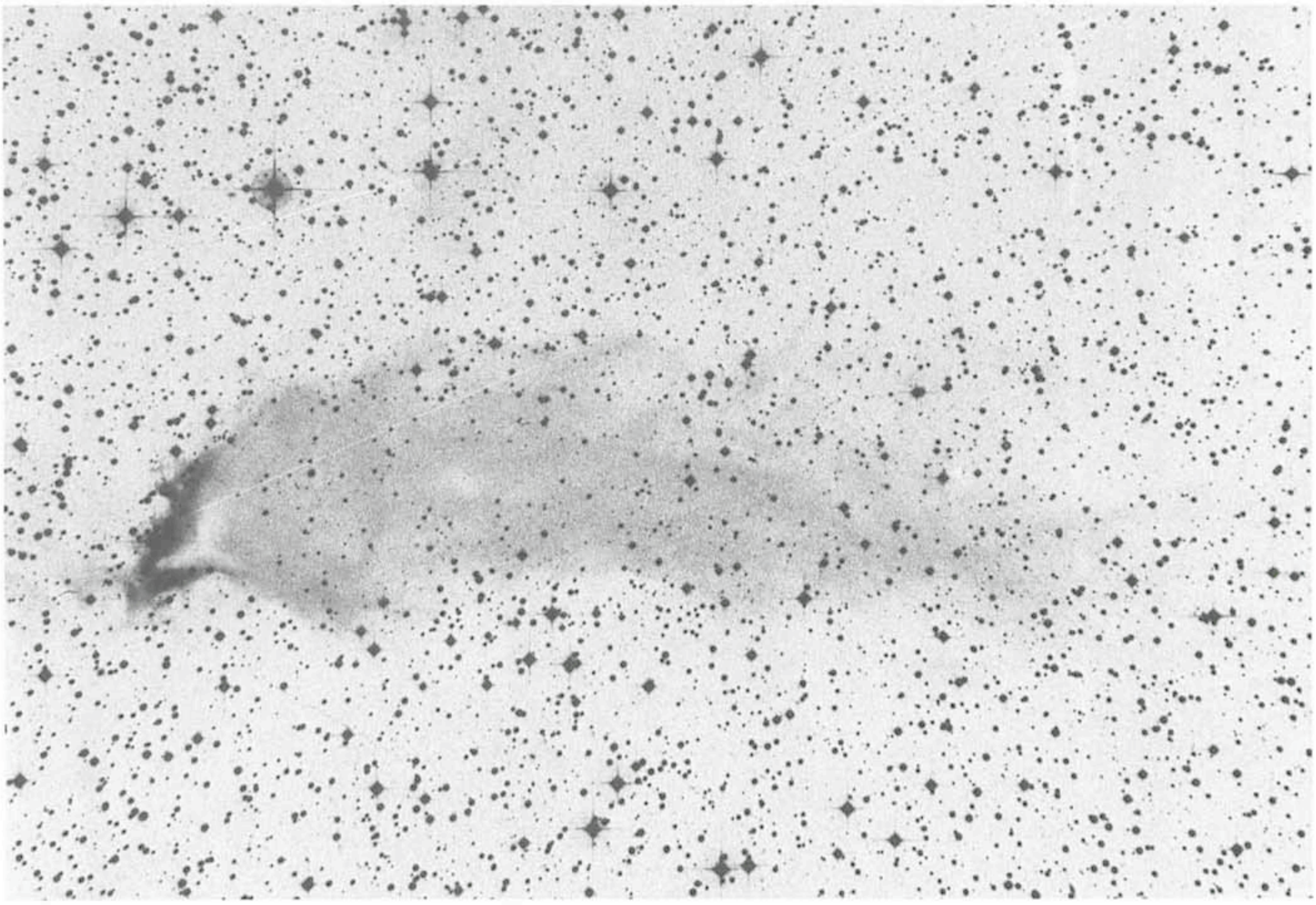

Fig. 1: *The cometary globule CG 1 in the Gum Nebula. The length of the tail is over 3 pc. Very close to the dense globule head covered with bright rims is the young pre-main-sequence star Bernes 135 (SRC-J Schmidt plate).*

of 50 $M_{\odot}$. Could it be that Bernes 135 was born out of the globule?

A star is usually safely regarded as a pre-main-sequence star when it fulfils the following four conditions: (1) The star is associated with nebulosity and dark clouds, (2) Hα is seen in emission in its spectrum, (3) The star is weakly variable in an irregular manner, (4) The flux distribution of the star shows an infrared excess. All these criteria are fulfilled by Bernes 135. Observations with various telescopes on La Silla over the past two years have shown that Bernes 135 has a peculiar composite emission/absorption spectrum, which can be interpreted as an early F star surrounded by dense circumstellar material. Figure 2 shows a blue IDS spectrum from the ESO 3.6-m telescope of Bernes 135. It is noteworthy that the Hβ line at λ 4861 has a central emission peak which is displaced bluewards, indicating outflow of matter with over 100 km/sec. Optical and infrared photometry shows that over 80% of the radiation from the star is being absorbed in this shell, which re-emits it as infrared radiation. Its visual magnitude varies by several tenths of a magnitude in an irregular manner on timescales of days, while its infrared magnitudes have been constant over nearly two years. The luminosity of Bernes 135 derived from the observations is almost 50 $L_{\odot}$, and its effective temperature is about 6,800 K. Compared to theoretical calculations of the evolution of pre-main-sequence stars this suggests a mass of roughly 2.5 $M_{\odot}$, a radius of about 5 $R_{\odot}$ and an age of about one million years.

The most common type of pre-main-sequence stars are the T Tauri stars, but the spectrum and the derived properties of Bernes 135 do not fit this group. Rather, it is hotter and more luminous than these stars, and seems to belong to a part of the HR diagram in between the T Tauri stars and the Herbig Ae/Be stars. These stars are more massive young pre-main-se-

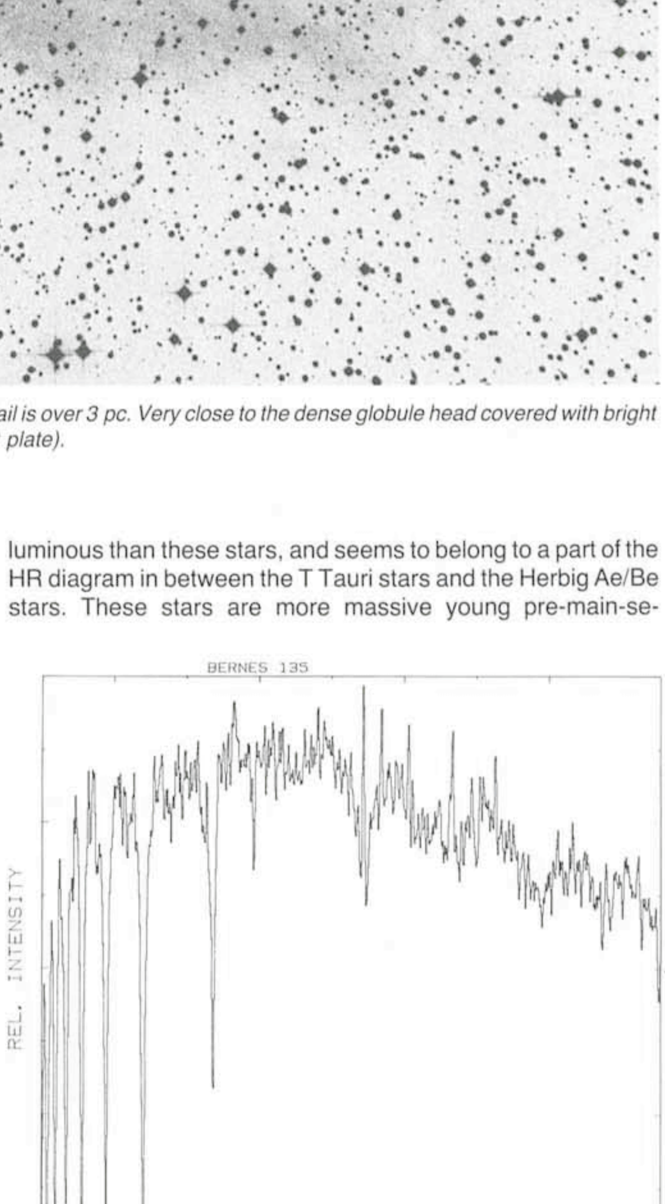

Fig. 2: *Blue 114 Å/mm spectrum of Bernes 135, taken with the IDS on the 3.6-m telescope by Walter Eichendorf. The Hβ line at λ 4861 shows a blueshifted central emission peak, indicating outflow of matter.*

quence stars, and Figure 3 shows a HR diagram with a number of them plotted together with Bernes 135.

The association between a highly unusual young pre-main-sequence star and a dense Bok globule provides compelling evidence that Bok globules, at least under the proper circumstances, can indeed form stars. CG 1 may well be the smallest observed dark cloud known to have formed stars.

Bok Globules and Herbig-Haro Objects

CG 1 is not the only one of the globules in the Gum Nebula which has formed stars, several of them are associated with stars and Herbig-Haro objects. Herbig-Haro objects are small nebulosities with peculiar forbidden emission-line spectra found in certain star-forming dark clouds. Often these objects are found close to a young star or an embedded infrared source, from which they move away with highly supersonic velocities. The Herbig-Haro objects may be associated with violent eruptions known to occur in some young stars.

An example of a Herbig-Haro object in one of the cometary globules in the Gum Nebula is seen in Figure 4. The Herbig-Haro object is the small oblong nebulosity near the center of one of the globules, numbered CG 30. This Herbig-Haro object is presently being studied by Pettersson and Westerlund, and its presence indicates that a young star is still embedded inside the globule.

Dark clouds are known to be inhomogeneous with "cores" of more dense material, and it is possible to understand the cometary globules in the Gum Nebula as such cores of dark clouds, exposed by the eroding effects of the ultraviolet radiation from the central O stars. Above the spectacular complex of globules in Figure 4 is seen a less dense, small dark cloud, an association known also for several others of the globules, and this can be understood as the remnants of the original cloud in which the core resided. In many cases, as in Figure 4, the globules show evidence of severe disruption, and this can be modelled using the theory of Rayleigh-Taylor and Kelvin-Helmholtz instabilities. The force involved is not radiation pressure, but the rocket effect, which arises when the ultraviolet radiation evaporates the outer layers of the globules, and the hot gas expands supersonically towards the O stars, pushing the globules away from the center of the Gum Nebula.

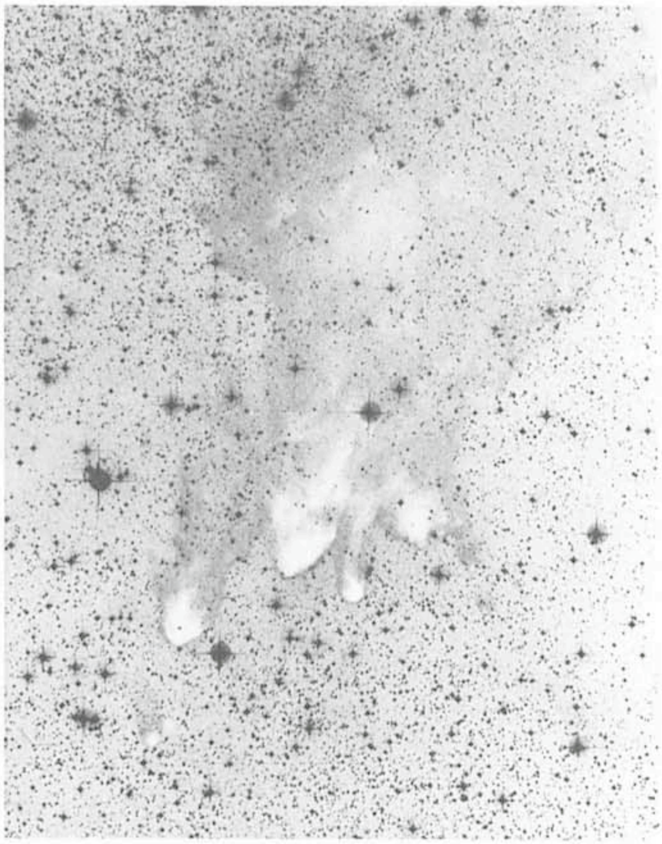

Fig. 4: *The CG 30/31/38 complex of cometary globules in the Gum Nebula. The globules show evidence of disruption. A Herbig-Haro object is seen as a small nebulous spot near the center of the globule CG 30 (SRC-J Schmidt plate).*

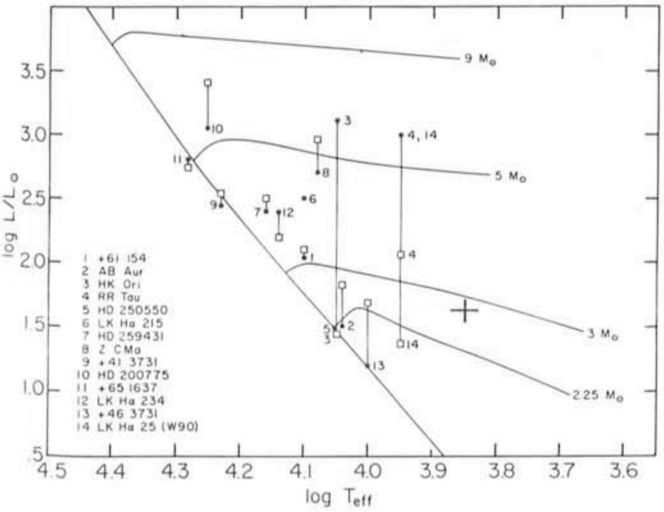

Fig. 3: *The position of Bernes 135 (shown by a cross) in a theoretical HR diagram with a number of young Herbig Ae/Be stars. (Diagram from Strom, S. E., Strom, K. M., Yost, J., Carrasco, L. and Grasdalen, G.:* Astrophysical Journal **173,** *353, 1972.)*

Calculations using estimates of the amount of ultraviolet radiation available together with the above-mentioned principles show that the globules have existed for roughly a million years, in relatively good agreement with the present age of the O stars in the center of the Gum Nebula, as well as the age of Bernes 135.

In short, the present work has proven Bart Bok to be right in his idea that globules can form stars. It is suggested that Bok globules are cores from small molecular clouds, exposed after the ignition of massive O stars producing copious amounts of ultraviolet radiation in the region. After the stripping of the cores, they are partly compressed, partly disrupted, and this forces several of the globules into star-forming collapses. In some cases the more massive O stars will die before the globules have been destroyed, leaving isolated globules scattered along the plane of the galaxy, slowly expanding and dissolving into the interstellar medium.

ESO USERS MANUAL

A new version of the ESO Users Manual is now available. It has recently been distributed to astronomical institutes; if your institute has not received a copy, please contact the Visiting Astronomers Section, Garching. ESO urges all its users to read the manual carefully before applying for observing time.

The manual will be updated periodically and any errors that should be corrected or any information you would like to be included should be communicated to the editor, Anthony Danks.