A NOTE ON THE POSSIBLE IMPORTANCE OF THE GUM NEBULA

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I would like at this time to develop my first astronomical catalog to which future generations of Gum Nebulists may refer. It is a catalog of

Theories and Vested Interests

C-1 There are a number of people for whom it is important that the Gum Nebula be some kind of fossil H II region, directly and almost wholly associated with the Vela X supernova remnant. Two groups come to mind:

C-IA is the group who have studied the region and proposed the possibility (Brandt, Stecher, Crawford, Maran, Alexander, . . .);

C-IB is the group who have proposed the time-dependent theory for heating and ionization of the interstellar medium, and who are studying the possible consequences on growth of instabilities and star formation (Bottcher, McCray, Dalgarno, Jura, . . .).

C-II There are several groups who are more particular about the kind of fossil H II region they want:

C-IIA formed by the immediate outburst of UV radiation from the SN explosion (Morrison, Sartori, Kafatos, . . .)

C-IIB formed by the gradual emission of UV radiation from the expanding, shock-heated remnant (Tucker, me*)

C-IIC formed by the immediate release of low-energy cosmic rays from the SN explosion, cosmic rays which are able to spiral along the magnetic field lines <u>without</u> sweeping those lines into a wall and thereby be confined within a shock, and which instead are able to

* Ph.D. thesis, La Jolla 1970, p. 105.

escape beyond the mechanical shock front to penetrate and ionize the medium beyond. These cosmic rays, although released immediately, require a substantial length of time to ionize the nebula because of their low velocities (Ramaty, Colgate, Boldt, Silk, . . .).

CIII One final group is not so much concerned with the remnant, but instead with the possible relationship between the pulsar(s), high-velocity stars, and the nearby B-associations in this region (Gott and Ostriker).

It seems to me that there are really two fundamental questions which need to be answered by the students of the Gum Nebula in order to make some of these catalog entries retire to the realm of pure historical interest:

(1) To what degree and scale is the ionization of the Gum Nebula region really due to the occurrence of one supernova event?

(2) What evidence exists which would indicate the mode or modes of energy transport from the SN to the interstellar medium, and the amount of energy transported?

In this regard, I think a two-step cooperative process between observers and theoreticians is required:

(1) Detailed observations of the 5°-diameter supernova remnant proper, coupled with a complete and credible model of the remnant which is capable of explaining the entire presently-observed spectrum, must be made.

(2) Detailed observations of the much larger H II region outside the remnant must be made over the complete spectral range. In addition, the model of the present remnant must be extrapolated backward in time to get its spectrum at earlier epochs. The necessary consequences of this earlier radiation on the surrounding interstellar medium must be subtracted from the presently "observed" distribution of ionization, temperature, cosmic rays and magnetic field to discover those residual effects attributable to other possible modes of energy transport from the SN explosion, not included in the model of the present remnant.

There are several measurements of the Gum Nebula which seem potentially very useful:

(1) We need a good series of spectra of some of the optical filaments in the SNR proper. There is some chance that these spectra can be matched

by calculations of the cooling behind a shock wave, such as I have performed for the Cygnus Loop. If so, this might help pin down the shock velocity and ambient density.

(2) I would like to see density and temperature measured by using [OII] and [OIII] lines in the regions in the Gum Nebula lying outside the SNR, but which show high emission measures. These can then be compared with calculations such as those by Kafatos and Morrison to determine whether it is possible for this material to have been impulse-heated 10,000 years ago. The studies should also measure the relative populations of various ions in order to determine the current ionization structure.

(3) It would be worth checking to see if the characteristic X-rays expected from the cosmic ray model of Ramaty, Boldt, Colgate and Silk are found in emission outside the SNR.

(4) The He^+ radio recombination lines, enhanced by dielectronic recombination as described by Dupree, should be studied, as should

(5) The intensity and spectrum of continuous X-ray emission outside the SNR.

(6) If the bright emission regions are actually found to be very hot, one might search for cooler ($T \sim 10^4$ °K) H II regions around the B stars, imbedded in the hotter material as predicted by Stecher in the discussions here.

In closing, I think that the idea advanced by Colgate to argue against the impulsive emission of UV by a SN explosion should be evaluated after relaxing the restriction (or verifying its validity) that the emission spectrum would resemble a black-body.