COSMIC RAYS FROM REGIONS OF STAR FORMATION
I. The Carina Complex

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Within the error circle of the COS-B gamma-ray source at $\ell = 288°$, $b = 0°$ (Wills et al., 1980) lies the Carina Nebula, one of the most active regions of star formation known, housing several OB associations and Wolf-Rayet stars (WRS), and perhaps also a supernova remnant (SNR). As a region containing intense mass-losing stars it belongs to the same species as the Rho Oph cloud (but much more active), suggested to be associated with the gamma-ray source at $\ell = 353°$, $b = +16°$ (Paul et al., this conference). As a group of OB association linked with a SNR, it belongs to the same species as "SNOB's" (Montmerle, 1979), possibly identified with about half of the COS-B sources. We suggest that the source at $\ell = 288°$, $b = 0°$ should be identified with the Carina complex. In this case the source would be at $\simeq 2.7$ kpc and its gamma-ray luminosity would be $\simeq 2.10^{35}$ erg s^{-1} . It is suggestive that the nearest aggregate of stars, gas and dust (Rho Oph) and the richest one (Carina) are both in the direction of a gamma-ray source. The Carina complex is noted in particular for the compact star clusters Tr 14, Tr 16 and Cr 228 (Humphreys, 1978), altogether comprising 6 of the 7 O3 stars observed in the Galaxy. It is also remarkable that 3 WRS are associated with the complex. All 3 WRS are of the WN7 type, having the highest mass-loss rate of WRS ($\simeq 10^{-4}$ $M_\odot$ yr^{-1}). Even more remarkable is the presence of the strange η Carina object which sheds mass at the extraordinary rate of 10^{-3} to 0.075 $M_\odot$ yr^{-1} , with a velocity of $\simeq 600$ km s^{-1} . Moreover, according to radio (Jones, 1973) and optical (Elliot, 1979) data, there seems to be a SNR buried in the Nebula. However, it is not seen at X-ray wavelengths by the Einstein observatory (Seward et al., 1979). This could be explained if the SNR has a luminosity $L_x < 10^{34}$ erg s^{-1} , since it could then be conceivably hidden by the unstructured, diffuse X-background. The molecular cloud associated with the Carina Nebula has been observed in the lines of H_2CO and OH (Dickel, 1974). The cloud has a derived mass of $\lesssim 10^5$ $M_\odot$, typical of other molecular clouds.

The inverse-Compton gamma rays emitted by the relativistic electrons in the SNR, inpinging on the UV and far-IR photons is, in the extreme $\simeq 30\%$ of the gamma-ray flux ; the same electrons interact with interstellar matter to produce gamma rays by bremsstrahlung. In certain conditions (matter density averaged over the emitting volume $\simeq 600$ cm^{-3} and magnetic field $\simeq 10^{-5}$ G.) the totality of the flux would be produced by this process (Montmerle and Cesarsky, 1980). However, in view of the lack of spectral informations above

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100 MeV, π° decay following proton collisions cannot be ruled out. Now if the SNR does not exist we may consider supersonic stellar winds (SSSW) as CR suppliers (Cassé and Paul, 1980).

The total mechanical power $\dot{P}_{car}$ injected by SSSW is as follows : i) From early type stars $P_{OB} \simeq 10^{38}$ erg. s^{-1} , ii) from WR stars, $P_{WR} \simeq 5.10^{38}$ erg. s^{-1} iii) From η Car, depending on the mass loss adopted, $P_\eta = 2.10^{38}$ to 2.10^{40} erg. s^{-1} . Therefore, at least $P_{car} = 8.10^{38}$ erg. s^{-1} i.e. at least 10^3 to 4.10^3 times the gamma-ray luminosity. If π° decay is the dominant gamma-ray production mechanism, the observed flux requires a CR proton density at least one order of magnitude higher than in the solar neighborhood. This implies that CR injected in the cloud by OB and WR stars, still very close to their birthplace, must be efficiently trapped there. This trapping in turn, allows CR to produce gamma rays very efficiently, since their lifetime against p-p collision is short in dense media (10^4 -10^5 yrs). Then altogether, and including the fact that low energy ($\lesssim$ 1 GeV) protons do not produce gamma rays by π° decay, the required acceleration efficiency is found to be $\lesssim 5.10^{-3}$.

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