X-641-69-140
PREPRINT

NASA TM X-63511

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APRIL 1969

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Last year saw the birth of observational gamma-ray astronomy with the detection of cosmic gamma-rays above 100 MeV energy by Clark, et.al.[1] Their results indicated that cosmic gamma-radiation is strongly anisotropic, being most intense in the galactic plane and particularly at the galactic center. There appears to be a background component of isotropic gamma-radiation of possible extragalactic origin (discussed previously by the author in reference 2) having a magnitude of $\sim 1 \times 10^{-4}$ $cm^{-2}sec^{-1}sr^{-1}$. Superimposed upon this background there appears to be a component from the galactic disk, having a line intensity of $1\text{-}2 \times 10^{-4}$ $cm^{-2}sec^{-1}rad^{-1}$. Gamma-rays coming from the region of the galactic center have a line intensity of $4\text{-}5 \times 10^{-4}$ $cm^{-2}sec^{-1}rad^{-1}$. Clark, et.al.[1] suggested that these fluxes, being an order of magnitude higher than those predicted from various diffuse production mechanisms, may originate mainly in unresolved discrete sources (a suggestion which was further explored by Ögelmann[3]). However, they were careful to point out that large amounts of undetected hydrogen may also account for these fluxes.

Recently, Shen[4] and Cowsik and Pal[5] proposed that the galactic gamma-rays may originate in Compton collisions of galactic cosmic-ray electrons with a large flux of infrared radiation as indicated by Shivanandan, et.al.[6], if such radiation fills the galaxy. At this point, neither the discrete source explanation nor the Compton explanation may be proved or disproved. It will be shown here that such is also the case with the collisional production mechanisms involving interstellar gas. Indeed, there may be a logical consistency between the gamma-ray results of Clark,et.al.[1] and recent results from other fields of astronomy concerning the galactic medium.

From 21 cm radio observations of the galaxy, it is found that the average value of the product of mean density and linear extension (usually denoted as $\langle nL \rangle$) for emitting atomic hydrogen in the galactic disk, spread out over the 15° resolution cone of the OSO-3 detector[1] is approximately 3×10^{21} cm^{-2}. This value corresponds to a mean density <u>in the disk itself</u> of approximately 0.5 cm^{-3}. If the atomic hydrogen seen in emission were to be considered the full content of hydrogen gas in the galaxy, the resultant gamma-ray production from π^{o} decay and cosmic-ray electron bremsstrahlung would then be a full order-of-magnitude below the observed value, as was concluded by Clark,et.al.[1] In other words, the collisional processes would require a mean interstellar gas density in the disk of the order of 5 cm^{-3} , of which only 10% is observed in 21 cm emission. However, as we shall see, there are several compelling arguments for such a mean density.

1) Gould and Salpeter[7] and Gould,et.al.[8] have pointed out that the observed spatial distribution of K-giant stars as a function of perpendicular distance from the galactic plane suggests a much stronger gravitational field for the galaxy than can be accounted for by stars and observed atomic hydrogen in the disk. A mean gas density in the disk of 5 cm^{-3} would be required to produce the observed K-giant distribution.

2) From an analysis of the observed distribution of atomic hydrogen gas and δ-Cephei variables, Dorschner,et.al.[9] have come to the same conclusion, suggesting that 80% of the interstellar gas is in the form of molecular hydrogen. They show that the unseen mass necessary to produce the galactic gravitational field would have to be very strongly concentrated toward the galactic plane and therefore would not likely be composed of stars.

3) From studies of the spin temperature of interstellar hydrogen from 21 cm line spectra, Mebold[10] has recently concluded that the total mass of interstellar hydrogen has been considerably underestimated from emission-line studies and that there exists a large quantity of gas which is in a condition

favorable for star formation, viz., in the form of cool, dense clouds.

4) Werner and Harwit[11] have observed a faint infrared emission feature which they have interpreted to be evidence for the existence of substantial amounts of molecular hydrogen in a dark cloud in Orion. The number of molecules along the line-of-sight is given as $\gtrsim 10^{21}$ cm^{-2}. Such clouds, although inherently difficult to observe, may be quite common in the galactic disk.

5) Since molecules such as NH_3, OH, H_2O and CH_2O exist in detectable quantities, it would be indeed surprizing if the H_2 molecule, made entirely of the most abundant element in the universe, did not exist in appreciable quantities.

6) Studies of external galaxies have indicated that regions containing young stars (regions of active star formation) do not coincide in many cases with the regions of maximum atomic hydrogen density as seen in 21 cm emission. This would not be at all surprizing if star formation occured mainly in cool, dense, unobserved clouds as suggested by Mebold.[10]

If we take all of this evidence into account, it appears likely that the gamma-ray observations of Clark,et.al.[1] can be interpreted as further evidence in support of an interstellar gas in the galactic disk with a mean density of 5 cm^{-3}. Production of neutral pi-mesons and bremsstrahlung in interstellar cosmic-ray collisions would then account for the observed gamma-rays. This hypothesis could be tested by future measurements of the energy spectrum of these gamma-rays in the vicinity of 70 MeV.

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