burning are about 50 per cent C^{12} and 50 per cent O^{16}, the actual ratios running from 1:2 to 2:1. This clearly implies that all such stars will pass through a carbon-burning phase which makes the determination of the $C^{12} - C^{12}$ reaction rate extremely important. For example, Hayashi, Hōshi, and Sugimoto (1962) found that, for 15.6 $M_\odot$, carbon burning occurs at temperatures where neutrino losses have become important. However, Hayashi *et al.* used a reaction rate derived from a square-well potential model of the interaction and the calculations of Vogt, Michaud, and Reeves (1965) show that the reaction rate is increased when the diffuseness of the well is taken into account. In addition, Brown (1966) has suggested that polarization effects on the highly deformed C^{12} nuclei may also increase the reaction rate at low energies. In any event, this question is still very much open. The possibility exists that carbon burning may occur at temperatures where neutrino losses are unimportant, even when calculated using the universal weak interaction coupling constant.

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THE LACK OF NEUTRAL HYDROGEN IN M5 AND M14

Roberts (1960) has speculated that interstellar neutral hydrogen might exist in globular clusters; but examination of the globular cluster M13 by Roberts (1959) and Goldstein (1964) showed that less than 150 $M_\odot$ of neutral hydrogen exist in this cluster. This letter presents the results of observing two other clusters, M5 and M14; M14 was mentioned by Roberts as a particularly good candidate for the presence of interstellar matter. The equipment employed was the 300-foot transit telescope (Findlay 1963) and the 100-channel autocorrelation receiver (Shalloway 1964) of the National Radio Astronomy Observatory (NRAO) at Green Bank. The beam width of the telescope is 10′ (approximately equal to the diameters of both clusters according to Arp [1965]), and its effective area is about 2830 m^2; the frequency resolution used was 12.5 kc/sec; the system noise temperature was about 200° K.

About seventy-five constant-declination drift scans across each object were obtained during May–August, 1965. The scans for M5 began at right ascension (1965.5) 15^h06^m and ended at 15^h25^m and covered the velocity range (with respect to the Sun) -8 to $+95$ km/sec; those for M14 were bounded by right ascensions 17^h26^m and 17^h42^m and velocities -46 to -153 km/sec. The line profiles were recorded every 10 sec of time; the data were printed by a computer as a matrix of antenna temperature versus velocity and right ascension throughout a scan. The map for each scan was examined carefully for the presence of any slight non-random effects from receiver instability or interference; about twenty-five scans for each object were rejected. The remaining scans were added together, yielding a total integration time per data point of about 12 min; the resulting rms noise temperature is about 0.15° K. We feel that an antenna temperature of 0.5° K could reliably have been observed since about four independent data points exist per antenna beam width.

We use Goldstein's equation for the hydrogen mass in terms of the observing parameters, which is valid if the hydrogen is optically thin and is concentrated in a region much smaller than the antenna beam, and we use the distances quoted by Arp. The resulting upper limits are 20 $M_\odot$ of neutral atomic hydrogen in M5 and 65 $M_\odot$ in M14. If the hydrogen is spread uniformly throughout the volume of a cluster, the upper limits decrease about 30 per cent; they are then firm limits, unaffected by optical depth effects, because the kinetic temperature of the hydrogen would certainly be larger than the observable brightness temperature (about 1° K). Alternatively, the hydrogen may be condensed into "intraglobular clouds" (Roberts 1960); in this case the upper limits do not apply, because the 21-cm optical depth can increase arbitrarily as the clouds become smaller. (The existence of intraglobular clouds has been inferred from the apparent existence of small obscured regions within a cluster [Roberts 1960]; the present authors are reinvestigating the possibility that these regions are due to statistical fluctuations in the distribution of stars.)

Although no hydrogen appeared at the position of either cluster, an apparent concentration of hydrogen appeared in the summed scan for M5 at a different right ascension. The apparent object seems to be isolated by both the spatial and frequency resolution; its mass is about 30 $M_\odot$ if its distance is the same as that of M5. It is located at right ascension (1950) $15^h20^m35^s$ and its velocity (with respect to the Sun) is $+14$ km/sec. The scans were taken at declination (1950) 2°09′. The signal, which is the only possibly significant one found in the data for both clusters, could be statistical noise; confirmation by further observations is desirable.

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X-RAYS FROM THE COMA CLUSTER OF GALAXIES

Experimenters at the Goddard Space Flight Center (Boldt, McDonald, Riegler, and Serlemitsos 1966) have reported an extended X-ray source of angular diameter 4°–5° and spectral flux $j \approx 10^{-2}$ (cm^2 sec keV)$^{-1}$ at 25 keV. The source is centered at $\alpha \approx 13^{\rm h}0^{\rm m}$, $\delta \approx +28°$, and they identify it as the Coma Cluster of galaxies. It is possible that this source is in fact nearer than the Coma Cluster; if it is galactic, it is probably in the disk and within 100 pc, since it lies at $b^{\rm II} \approx +88°$. Assuming, however, that the identification is correct, it implies a surprisingly large X-ray luminosity for this cluster. These X-rays might be produced in (*a*) individual galaxies within the cluster, or (*b*) the intergalactic medium. In this Letter we consider (*a*) briefly and show that the superposition of individual galaxies probably cannot produce the observed flux. We then resort to (*b*) and find that the emission is accounted for by a mass of hot gas equivalent to the familiar missing mass suggested by application of the virial theorem to this cluster, provided $T \sim 10^8$ °K.

The Coma Cluster (Abell 1965) lies at a distance of 90 Mpc (for $H = 75$ km sec^{-1} Mpc^{-1}, which we assume throughout), so that the photon emission by the cluster at 25 keV is $J \approx 1 \times 10^{52}$ sec^{-1} keV^{-1}. It contains more than 800 and possibly a few thousand galaxies brighter than $M_{\rm pv} \approx -17$; 1500 is a reasonable estimate. If the total cluster output is just the superposition of individual galaxies, it follows that the mean emission per galaxy in the Coma Cluster is $\langle J_g \rangle \approx 7 \times 10^{48}$ sec^{-1} keV^{-1}. The same quantity for our own Galaxy, J_G, may be estimated fairly well from the observed flux due to the cluster of discrete sources near the galactic center: $(16 \pm 5) \times 10^{-9}$ erg cm^{-2} sec^{-1} in 20–30 keV (Giacconi, Gursky, Waters, Rossi, Clark, Garmire, Oda, and Wada 1965). Assigning an appropriate distance, ≈ 10 kpc, we find $J_G \approx 5 \times 10^{44}$ sec^{-1} keV^{-1}; the *average* galaxy in the Coma Cluster is $\approx 10^4$ times brighter at 25 keV than our own!

Before attempting to interpret this surprising result, we may make another comparison. The background flux per steradian, $\delta j_B/\delta\Omega$, due to all unresolved galaxies in the Universe may be estimated from

$$\delta j_B/\delta\Omega \sim (4\pi)^{-1} n_g \langle J_g \rangle R \qquad (1)$$

if the mean emission per galaxy $\langle J_g \rangle$ is known. Here n_g is the mean number density of galaxies in space, often given as $\approx 1 \times 10^{-75}$ cm^{-3} (Sandage 1965); this number is appropriate if galaxies down to $M_{\rm pg} \approx -17$ or a little brighter are counted (van den Bergh 1961; Kiang 1961). R in approximation (1) is a cosmological path length which may be taken $\sim c/2H$ for most cosmological models (Whitrow and Yallop 1964; Felten 1966). If we now assume that $\langle J_g \rangle \approx \langle J_g \rangle_{\rm Coma}$, we find from equation (1) that the isotropic X-ray flux at 25 keV should be ~ 3 (cm^2 sec sterad keV)$^{-1}$. But the observed flux (Bleeker, Burger, Scheepmaker, Swanenburg, and Tanaka 1966; Hayakawa, Matsuoka, Ogawa, and Yamashita 1966; Rothenflug, Rocchia, and Koch 1966) is smaller by a factor ~ 30. Earlier workers have similarly used equation (1) to estimate the unresolved background, taking the luminosity of our Galaxy J_G as model for $\langle J_g \rangle$, and it has been shown (Oda