It may be worth while to indicate the present status of the measurements of the moments of the gallium isotopes. From the results of Pound[5] and of Bitter[6]

$$\mu(\mathrm{Ga}^{71})/\mu(H^1)=0.9148\pm0.0004$$

and

$$\mu(\mathrm{Ga}^{69})/\mu(H^1)=0.7203\pm0.0006,$$

where the moments are uncorrected for diamagnetic effects.

Becker and Kusch have calculated the moments of the gallium isotopes on the basis of the assumption that $g_J(^2P_{\frac{1}{2}})=\frac{2}{3}$. Since this assumption is subject to correction because of the anomalous spin moment of the electron, and since an arithmetical error exists in the previously published values, the data have been recalculated. With the help of the known auxiliary ratios $g_J(^2P_{\frac{1}{2}}, \mathrm{Ga})/g_J(^2S_{\frac{1}{2}}, \mathrm{Na})$ and $g_I(H^1)/g_J(^2S_{\frac{1}{2}}, \mathrm{Na})$:

$$\mu(\mathrm{Ga}^{71})/\mu(H^1)=0.9078\pm0.0015$$

and

$$\mu(\mathrm{Ga}^{69})/\mu(H^1)=0.7146\pm0.0015.$$

In each case the discrepancy between the nuclear resonance values and the h.f.s. values is about three times the sum of the stated uncertainties. The discrepancy appears to be real, especially in view of the excellent agreement between the ratio of the moments of the two isotopes of gallium.

In the experiments on the determination of the magnetic moment of the electron,[7] a large volume of data on the frequencies of lines in the h.f.s. spectrum of Ga was obtained. Nine sets of data exist from which it is possible to determine the ratio g_I/g_J for Ga^{69}. It is then found that $\mu(\mathrm{Ga}^{69})/\mu(H^1)=0.7143\pm0.0015$. The agreement with the ratio previously obtained from h.f.s. data is excellent and points to the reality of the discrepancy of about 0.7 percent between the ratio obtained from the nuclear resonance method and h.f.s.

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Cosmic Radiation and Radio Stars

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THE normal radio wave emission from the sun amounts to 10^{-17} of the heat radiation, and increases during bursts[1] to as much as 10^{-13}. If a radio star, e.g., the source in Cygnus, is situated at a distance of 100 light years, its radio emission is of the order of 10^{-4} of the heat radiation of our sun. It is very unlikely that the atmosphere of any star could be so different from the sun's atmosphere as to allow a radio emission which is 10^9 to 10^{13} times greater, and it seems therefore to be excluded that the source could be as small as a star. The recent discovery[2] that the intensity variations of radio stars is a "twinkling" makes it possible to assume larger dimensions.

Ryle has suggested that there should be a connection between radio stars and cosmic radiation.[3]

According to a recent development of Teller and Richtmyer's theory of cosmic radiation, the sun should be surrounded by a "trapping field" of the order 10^{-6} to 10^{-5} gauss, which confines the cosmic rays to a region with dimensions of about 10^{17} cm (0.1 light year).[4] It is likely that almost every star has a cosmic radiation of its own, trapped in a region of similar size. We suggest that the radio star emission is produced by cosmic-ray electrons in the trapping field of a star.

Electrons with an energy $W\gg m_0c^2$ moving in a magnetic field H radiate at a rate

$$-dW/dt=(2e^2/3c)\omega_0^2\alpha^2, \qquad (1)$$

where[5] $\omega_0=eH/m_0c$ is the gyro-frequency corresponding to the rest mass m_0, and $\alpha=W/m_0c^2$. Most of the energy is emitted with a frequency of the order

$$\nu=\omega_0\alpha^2/2\pi=2.8\times10^6 H\alpha^2 \text{ sec.}^{-1}. \qquad (2)$$

As soon as the energy is much higher than the rest energy the emitted frequency becomes much higher than the gyro-frequency, a phenomenon which is observed in large synchrotrons, where the electron beam emits visual light.[6]

According to (2) an emission of radio waves of 100 Mc/sec. requires

$$H\alpha^2=36 \text{ gauss}. \qquad (3)$$

The acceleration process of cosmic radiation should accelerate electrons as well as positive particles. In the solar environment the electron component is eliminated by Compton collisions with solar light quanta as discussed by Feenberg and Primakoff.[7] In the neighborhood of a star which does not emit much light, the electrons would be accelerated until their energy is so high that they radiate. The wave-length falls in the meter band if, for example, $\alpha=300$ ($W=1.5\times10^8$ ev) and $H=3\times10^{-4}$ gauss. This field is about 100 times the estimated strength of the sun's trapping field. As the strength is determined by the "interstellar wind," a radio star should be situated in an interstellar cloud moving rather rapidly relative to the star.

In order to account for the total energy emitted by a radio star we must suppose either that the radio emission is a transitory phenomenon, lasting a time which is short compared to the lifetime of cosmic rays in the trapping field (10^8 years), or that the cosmic-ray acceleration close to the star is supplemented by a Fermi process[8] further out in the trapping field.

According to the views presented here, a radio star must not emit very much light, and should be situated in an interstellar cloud. This would explain why it is so difficult to find astronomical objects associable with the radio stars.

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The Doublets of N^{15} and O^{16}

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THE nuclear energy-level spectra[1,2] of N^{15} and O^{16} are each characterized by two or more doublets having splittings of 30 to 200 kev and separated by about 1 Mev or more, in the region of excitation 5 to 8 Mev. The lack of structure[1] in the ground state of N^{15} and the importance of spin-orbit coupling in the heavier nuclei[3] suggest that the spin-orbit coupling energy is probably too large for these to be spin-orbit doublets. It is noteworthy that these nuclei at the end of the p-shell in the usual shell model[4] have a much wider gap from the ground level to the first known excited state than have other light nuclei, and the first excitation energy, 5 or 6 Mev, seems to be the energy required to excite a nucleon from the p-shell to the next shell. The nuclear spin and magnetic moment of F^{19}, being similar to a proton's, indicate that the next nucleon state is an s-state. In O^{16}, such an excited s-nucleon, if loosely coupled to the remaining $^2P_{\frac{1}{2}}$ hole of the p-shell (similar to N^{15} or O^{15}) would give rise to adjacent states having $I=0$ and 1, a sort of doublet which might be called an "intershell j-j coupling doublet" or simply a "j-j doublet." Calculations neglecting tensor forces show that for most types of central attractive forces between nucleons the

$I=0$ state lies below that for $I=1$, thus providing the $0-0$ transition necessary to explain the well-known pair emission of the lowest excited state in O^{16}, and that the order of magnitude of the splitting is compatible with reasonable assumptions about the interactions. In N^{15} one may have an excited s-nucleon coupled to a p-shell resembling C^{14} or N^{14} having $J=0$ or 1 (or more) and giving rise to single levels and doublets.

Such an interpretation has a simplicity appropriate to the simple doublet pattern observed and to other indications of nuclear shell structure, but in detailed consideration of the lower doublet of O^{16} it unfortunately encounters obstacles which, unless otherwise overcome, make it desirable to seek instead a mechanism capable of pairing states of quite different angular momentum, since the doublets seem too numerous to be fortuitous. Wayne Arnold has recently observed[5] a pronounced alpha-gamma-angular correlation in $F^{19}(p,\alpha)O^{16}$ which seems to indicate $I=3$ rather than $I=1$ for the 6.1_4 Mev state of O^{16}, in striking contrast to $I=0$ for the 6.0_6 Mev state. Furthermore, the odd parity of the configuration p^5s, while consistent[6] with the existence of the three known pair resonances, requires that the two known pair-plus-long-range-alpha-resonances be chance superpositions of states of different parity-angular-momentum in the rather crowded spectrum of Ne^{20}.

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The Half-Life of Cm^{242}

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During recent work on the neutron irradiation of americium it was noticed that the Cm^{242} produced decayed at a rate significantly different from that expected from the published half-life of 150 days.[1] Accordingly an attempt was made to measure this half-life with reasonable precision.

Three sources were available whose disintegration rates were known with adequate accuracy at a sufficiently early date to give a good value for the half-life. These were all unseparated sources containing the whole of the parent americium. This is not a serious drawback as the curium α-rays are more energetic and were well resolved from the α-rays from any isotope of americium present. A small correction has to be made, however, for the growth of Cm^{242} from the long-lived ground state of Am^{242} which is present.[2]

The activity of the sources was measured in a low geometry proportional counter using a 30 channel pulse analyzer. The counter, designed in this laboratory by Mr. A. G. Ward several years ago, can be trusted to maintain a constant geometry over an indefinite period of time. It consists essentially of a vertical cylinder with a removable base on which is placed the source to be counted. The lower half of the cylinder contains a collimator defining the geometry. The space above the collimator hole contains a proportional counter. The whole is filled with methane at a suitable pressure. The pulse size is a measure of how far an α-particle has penetrated the counting volume and consequently the several disintegration rates of the components of a mixed source can be measured simultaneously.

Table I. Disintegration data on Am^{241} and Cm^{242}.

Source	Date	Days	Am^{241} disin./min.	Cm^{242} disin./min.	Ratio Cm/Am	Half-life calculated from time zero
			$(\times 10^{-5})$	$(\times 10^{-5})$		
A	16:2:49	0	1.492±0.017	2.550±0.021	1.709±0.022	—
	1:11:49	257	1.465±0.014	0.832±0.008	0.568±0.008	161.8±2.7
	16:2:50	365	1.481±0.014	0.537±0.005	0.362±0.005	163.1±2.2
			$(\times 10^{-5})$	$(\times 10^{-7})$		
B	18:7:49	0	5.5±0.2	6.522±0.020	—	—
	25:11:49	130.2	not measured	3.747±0.010	—	162.9±1.5
			$(\times 10^{-5})$	$(\times 10^{-6})$		
C	3:6:49	0	1.5±0.1	21.58±0.14	—	—
	20:11:49	180	1.6±0.1	9.987±0.020	—	162.0±1.5
	14:2:50	256	1.6±0.1	7.254±0.020	—	162.7±1.0
	16:3:50	286	not measured	6.364±0.015	—	162.3±0.9

The three sources were all prepared by evaporation from solution on mirror-finish platinum disks and ignited to red-heat. *Source A*, produced by a very short irradiation, gave comparable Am^{241} and Cm^{242} disintegration rates. *Sources B and C* were aliquots of much more heavily irradiated sample of americium.

Source A was rather small, requiring very long counting times for good statistical accuracy, but the americium and curium counting rates could be measured with comparable precision. With sources B and C the very intense curium activity was accompanied by a finite low energy tail which precluded a very accurate estimation of the americium. The total activity of these two sources was measured and the result corrected for the presence of americium and the growth of Pu^{238}. The uncertainty in these corrections was not large enough to produce a significant error. The geometry of the counter was checked by counting a standard Pu^{239} source on each occasion. The results are given in Table I.

We are somewhat apprehensive that the sources would be weakened by aggregate recoil and give a spuriously short half-life. The constancy of the americium counting rate of source A suggests that this effect is small since it is likely that americium would accompany any curium removed in this way. However, a more satisfactory check that this effect was not significant was obtained by monitoring the inside of the containers in which the sources had been kept: no activity was detected with an instrument sensitive to a few hundred α-disintegrations per minute.

It is possible that sources B and C contain some Cm^{243} formed by a second neutron capture during irradiation. However, the α-activity from this isotope is not expected to exceed a few tenths of one percent of the Cm^{242} activity. The agreement between the half-lives from B and C and the lightly irradiated source A suggest an upper limit of about $\frac{1}{2}$ percent.

Seaborg, James, and Morgan[2] have shown that in neutron irradiated americium there occurs about one β-disintegration of the long-lived ground state of Am^{242} for every 1000 α-disintegrations of Cm^{242} in a fresh unseparated sample. In our measurements the correction for this growth of curium amounts to -0.2 day in the half-life.

Our "best value" is $162.7-0.2$ days $=162.5$ days. The limits of error are probably ± 2 days.

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Measurement of Gamma-Ray Energies with One Crystal*

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The use of scintillations in a single crystal to measure gamma-ray energies[1] may have important applications in nuclear physics because of the possibility of examining sources of very weak radioactivity. In view of this attractive possibility we have studied the pulse-height distributions in clear NaI(Tl)