and

$$C(D,\lambda)=C(D)+\tfrac{1}{2}e^{\alpha^2/4}\{e^{\alpha x_1}[1-\Phi(x_1+\tfrac{1}{2}\alpha)]-e^{-\alpha x_2}[1+\Phi(x_2-\tfrac{1}{2}\alpha)]\}, \quad (4)$$

where

$$x_1\equiv(\tau-D)/2\langle\Delta t\rangle_{Av},\quad x_2\equiv(\tau+D)/2\langle\Delta t\rangle_{Av},\quad \alpha\equiv2\lambda\langle\Delta t\rangle_{Av}.$$

Equation (4) also approaches a pure exponential decrease for large D.

The author would like to thank Mr. William J. MacIntyre for the use of his data and Professor Howard L Schultz for many discussions concerning coincidence techniques.

* Assisted by the joint program of the ONR and the AEC.

[1] S. D. Benedetti and F. K. McGowan, Phys. Rev. **74**, 728 (1948).
[2] P. T. Bittencourt and M. Goldhaber, Phys. Rev. **70**, 780 (1946).
[3] F. W. Van Name, Phys. Rev. **75**, 100 (1949).
[4] W. J. MacIntyre, Phys. Rev. **76**, 312 (1949).
[5] F. W. Van Name, Ph.D. dissertation.
[6] H. Bradt and P. Scherrer, Helv. Phys. Acta **16**, 251 (1943).

On the Half-Life of Na^{22}

L. JACKSON LASLETT
*Institute for Atomic Research and Department of Physics, Iowa State College, Ames, Iowa**
August 8, 1949

THE radioactivity of Na^{22}, first discovered by Frisch,[1] has been described by the present writer[2,3] as producible by the deuteron bombardment of magnesium and the half-life estimated as 3.0 years.[3] More recently, Saha[4] has given a value of 2.8 years for the half-life of this activity. During the past three years the decay of a Na^{22} sample has been followed in this laboratory and it is the purpose of the present note to report the value obtained for the half-life.

The Na^{22} sample used was produced in 1937 by the bombardment of magnesium metal with deuterons produced by the cyclotron in Professor Lawrence's laboratory at Berkeley. The magnesium target was subsequently mounted in the recess of a brass plate, covered with a mica sheet hermetically sealed to the brass, and, by means of a Lauritsen electroscope,[5] its activity was compared at intervals with that from a standard uranium oxide source

The resultant decay curves, for two different source positions, are shown in Fig. 1 and indicate a half-life of 94^8 days or 2.6^0 years.[6] It should be mentioned that diffusion of the active material from the surface into the magnesium metal would, if appreciable, result in an underestimation of the half-life, since the greater portion of the activity measured was readily absorbable (positrons). Some confirmation of the belief that diffusion and similar processes played no significant role in the present work is afforded, however, by the observation that absorption curves taken at the beginning and end of the measurements (curves 1 and 2 of the insert, Fig. 1) appeared entirely similar and were in agreement with one obtained[3] shortly after the sample was first prepared.

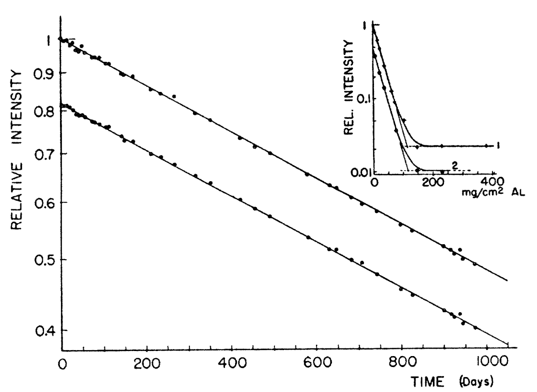

FIG. 1. Logarithmic decay curves of Na^{22} activity, measured with respect to that of an uranium oxide standard, for two source positions. *Insert*: Aluminum absorption curves (logarithmic scale of ordinates) taken (1) at the beginning and (2) after completion of the decay measurements.

It is a pleasure for the writer to indicate once again his gratitude to Professor Lawrence for the privilege of using the cyclotron in connection with the preparation of the sample used in the work reported here.

* Contribution No. 80 from the Institute for Atomic Research. Work performed at the Ames Laboratory of the AEC.

[1] O. R. Frisch, Nature **136**, 220 (1935).
[2] L. J. Laslett, Phys. Rev. **50**, 388(A) (1936).
[3] L. J. Laslett, Phys. Rev. **52**, 529 (1937).
[4] N. K. Saha, Trans. Bose Res. Inst. (Calcutta) **14**, 57 (1939–41); cited in Chem. Abstracts **42**, 450i (1948).
[5] The electroscope, manufactured by the F. C. Henson Company (Pasadena), was used to measure the ionization in a chamber approximately $2\frac{1}{4}$ inches in diameter and 3 inches long, into which the radiation passed through an aluminum window of 1.2 mg/cm² surface density. The surface density of the mica covering the source was 5.2 mg/cm². We are indebted to Dr. A. F. Voigt for making available to us this electroscope in its modified form.
[6] A value of 2.6 years was provisionally communicated to Dr. G. T. Seaborg during the course of this work and has subsequently appeared in the review article of Seaborg and Perlman (Rev. Mod. Phys. **20**, 585 (1948)).

Microwave Spectrum of CF_3Cl

D. K. COLES AND R. H. HUGHES
Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania
August 1, 1949

THE CF_3Cl rotational transitions between $J=2$ and 3 and between $J=3$ and 4 have been observed in the microwave regions around 20 kmc and 27 kmc. Thirty-one lines were measured, including five lines which are attributed to molecules in an excited vibrational state. The hyperfine structure spacing yields quadrupole coupling constants of 78.05 ± 0.2 and 61.44 ± 0.4 mc for CF_3Cl^{35} and CF_3Cl^{37}, respectively.

At a pressure of 0.1 mm, the line widths were approximately 5 mc, corresponding to a molecular collision cross section of 1400A².

The values of B_0 for CF_3Cl^{35} and CF_3Cl^{37} were found to be 3335.56 and 3251.51 mc, respectively. From these values one may calculate that the distance of the Cl nucleus from the center of mass of the CF_3 group is 2.129A, and that the moment of inertia of the CF_3 group about an axis through its center of mass and perpendicular to the symmetry axis is 46.31 mass units times angstroms².

If one assumes tetrahedral angles, one then obtains for the internuclear distance $C-F=1.323$A and $C-Cl=1.765$A. These are quite consistent with electron diffraction values on similar fluorochloromethanes.

Hyperfine Structure of Fe 57*

JEAN BROSSEL
Spectroscopy Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts
August 1, 1949

A SEARCH for the hyperfine structure of Fe 57 was carried out by means of a Fabry-Perot interferometer, crossed with a 35-foot concave grating in the Wadsworth stigmatic mounting (the blaze being in the second order).

The wave-length scale covered extended between 6000A and 2400A. No structure, broadening, or asymmetry was found. The resolution obtained would have revealed any over-all structure greater than $25\cdot10^{-3}$ cm^{-1} between 6000 and 4000A and $50\cdot10^{-3}$ cm^{-1} near 2500A. The discharge tube was a hollow cathode cooled with liquid nitrogen, the carrier being argon with a trace of helium. The spectrum was very extensive and was readily photographed. At least 400 lines were examined. Among others, the following electron configuration of Fe I were involved: $3d^74s$, $3d^64s4p$, $3d^64s4d$ and $3d^64s5s$, $3d^64s^2$, $3d^74p$. It was not found possible to excite Fe II by changing widely the conditions of the discharge.

TABLE I.

λ	Classification	$\Delta\nu_{\text{calc.}}$ 10^{-3} cm^{-1}	$\Delta\nu_{\text{meas.}}$ 10^{-3} cm^{-1}	
5446·920	$\{a^5F_2-z^5D_2^0$ / $(a^3F_2-z^3D_3^0)\}$	+160		very weak—not measured
5404·144	$\{z^3G_4^0-e^3H_5$ / $(z^5G_5^0-f^5G_5)\}$	+120	+117	
4210·352	$z^7D_1^0-e^7D_1$		−226	
4466·554	$\{b^3P_2-x_3D_3^0$ / $(a^5D_1-z^7F_0^0)\}$	−120	−77	
3684·108	$a^3G_4-v^3D_3^0$		−227	
3682·226	$a'D_2-w'D_2^0$		+245	
3605·450	$\{a^3G_4-y^3H_4^0$ / $(z^7F_6^0-f^7D_5)\}$	−400	−368	
3383·692	$\{a^5P_2-w^3D_1^0$ / $(b^3G_5-9_4^0)\}$	+140		very weak—not measured
3306·356	$\{a^5P_1-v^5P_2^0$ / $(a'G_4-w'G_4^0)\}$	+50	132	same intensity
3239·436	$\{z^7D_4^0-f^5D_4$ / $(z^7D_1^0-f^5D_1)\}$	−220	−224	
3214·044	$\{z^7D_3^0-e^7P_2$ / $(z^5F_4^0-g^5G_5)$ / $(z^7D_3^0-f^7D_3)\}$	+380 / +530	+360 / +490	
3199·530	$\{z^7D_4^0-f^7D_4$ / $(a^5D_1-z^3F_2^0)\}$	+290	+302	
3125·653	$\{a^5F_2-x^5D_3^0$ / $(z^7D_5^0-e^7G_4)\}$	−30	+297	
2970·106	$\{a^5D_1-y^5F_2^0$ / $a^5D_2-z^3P_1^0\}$	−210	−230	

The above results are in agreement with those reported recently[1] and similar to those concerning Ni 61.

A point which might be of interest that was noticed during the course of the research was the resolution of a few lines coinciding accidentally that have not been reported before. These lines are listed below with Russell's[2] classifications, the separations calculated from the term analysis, and the separations actually observed (see Table I). ($\Delta\nu>0$ means that the weak component has a higher frequency than the strong component from which it is measured.)

There is agreement with the Zeeman effect data of D. W. Weeks.[2]

The sample of Fe 57, enriched to 68 percent, was provided by the AEC.

* Assisted by the joint program of the ONR and the AEC.

[1] M. Gurevitch and J. G. Teasdale, Phys. Rev. **76**, 151 (1949).

[2] Russell, Moore, and Weeks, Trans. Am. Phil. Soc. **34**(II) (December 1944).

Energetic Events in Emulsions at High Altitude*

J. HORNBOSTEL AND E. O. SALANT
Brookhaven National Laboratory, Upton, Long Island, New York
August 4, 1949

IN Eastman NTB3 emulsions, exposed with planes vertical at 93,000 feet for 6 hours near Cuba (31° geomagnetic north; vertical cut-off 8 Bev[1]), many stars show straight, light tracks of minimum and near-minimum grain density, in addition, of course, to the heavy prongs visible in ordinary, less sensitive emulsions. While the light tracks can be safely ascribed to fast particles, of relativistic and near-relativistic kinetic energies, and are thought due at least in part to mesons, the portions of tracks within the emulsions are too short to decide from their appearance whether the particles are electrons, mesons or protons. Near-minimum grain densities refer to kinetic energies between 0.2 and 0.6 rest energy.

Out of 124 stars with light tracks, 76 showed, in the hemisphere above the star, a minimum ionization track, which is taken to be that of the incoming particle initiating the disintegration, either a primary proton or, in possibly a third of the events, a secondary of comparable energy, ejected from the thin (15 g/cm^2) atmosphere above the plates.

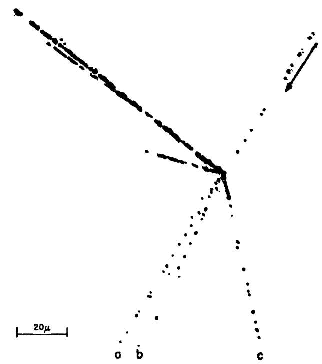

FIG. 1. Disintegration with 4 minimum ionization tracks within 43° and 4 heavy prongs. Between *a* and *b* are 3 min.-ion tracks within 20°, one dipping out of focus. Fourth track *c* is within 43° of *a*. Background removed.

Figures 1 and 2 are microphotographs of stars with some characteristic features of the light tracks (arrow indicates track of incident particle). Selecting the 47 events with 4 or more light tracks, 35 of them show 3 or more light tracks fanning out downward, roughly in the direction of the incident particle, giving the appearance of a broom. But in 10 of the broom, the handle, i.e., the incident particle, is missing, and while a few misses could arise from possible closeness to the inconvenient normal to the plate, the rest are attributable to non-ionizing radiation, presumably energetic neutrons. In the remaining 12 events, the fast particles appear uncollimated.

Outgoing light tracks in these brooms number 6 on the average, extending up to 12, and 120 of the 210 tracks have minimum ionization, the angles of near-minimum tracks being widely and rather uniformly spaced. In 27 of the brooms, there are usually 3 or 4, sometimes as many as 9, minimum ionization tracks, contained within a narrower broom, with angular spread generally between 50° and 100°. In 8 of these events, about the same number of minimum ionization tracks are in a still narrower core, of less than 20° spread. Thus it appears that the relativistic particles are more closely collimated than the near-relativistic and their angular spreads tend to fall into two groups. There is also evidence, though not yet statistically sound, for some fast particles to be created in pairs, within a few degrees of each other.

Considering, now, the stars' heavy prongs (uncollimated), 70 out of 90 of those stars with enough heavy prongs to be assigned to disintegrations of the heavy nuclei Ag, Br and I show emission of relativistic or near-relativistic particles. Very energetic stars, with up to 36 heavy prongs and 7 light tracks are observed. Even with an average of 35 Mev per prong found by Harding, Lattimore and Perkins[2] (likely to be higher at our latitude and altitude), over

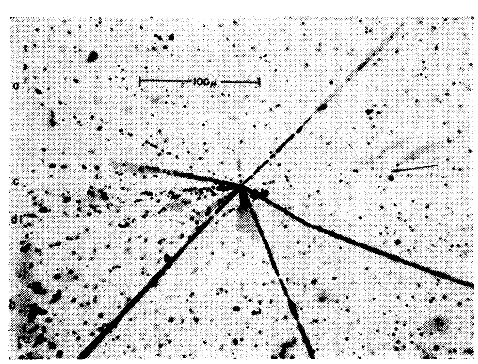

FIG. 2. Disintegration with 12 heavy prongs, 12 min. and near-min. tracks within 100°. Between *a* and *b*, 52° apart, are 8, and between *c* and *d*, 10° apart, are 5 minimum ionization tracks.