favor the vertical counters and produce the discrepancy observed. However, the narrow showers have appreciable effect only at counter spreads less than 90 cm. Thus the arrangements *AEG* and *BFH* of Fig. 1 are not affected by narrow showers from any direction.

I am indebted to the Climax Molybdenum Company for the use of their facilities while carrying out this experiment, and to the University of Chicago for lending some of the equipment which was used. I also wish to thank Professor C. G. Montgomery for helpful discussions.

* Assisted by the Joint Program of the ONR and the AEC.

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The "1947 Values" of the Atomic Constants and the Revision of the Faraday Constant*

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IT is well known that the two precision determinations of the Faraday by electrochemical methods (1) by the silver voltameter,[1] (2) by the iodine voltameter[2] fail to agree by considerably more than their estimated probable errors warrant.

$$F_{Ag}=9650.5 \text{ e.m.u./g} \quad \text{(physical scale)},^3$$
$$F_{I}=9652.2 \text{ e.m.u./g} \quad \text{(physical scale)}.^3$$

Nevertheless, F_{Ag} has long been the value accepted, perhaps in part because it has been regarded *as correct by definition.*

It seems to the writer that such an empirical definition is unfortunate and this universal constant should preferably be defined in a *fundamentally significant* way, i.e., as the quantity of electricity, N_0e, (N_0=Avogadro's number and e=the electronic charge) or the charge *associated with* one gram-atomic weight of singly ionized atoms. Fortunately, in this more fundamental sense of the Faraday it can now be, and recently has been precisely measured. J. A. Hipple, H. Sommer, and H. A. Thomas at the National Bureau of Standards[3] determine by means of their newly developed "omegatron" the charge-to-mass ratio e/M_{H^+} for gaseous H^+ ions. After multiplication by the isotopic weight of H^+ (1.007580 ± 0.000003) they obtain the Faraday (in the sense here proposed). A preliminary result is

$$F=9652.8\pm0.8 \text{ e.m.u./g (physical scale)}$$

indicating that the iodine Faraday (rather than the silver) was nearer the truth.

The Faraday can be computed from certain spectroscopic data without appeal to electrochemistry and R. T. Birge was the first to point out[4] that when this is done one obtains a value somewhat higher than F_{Ag} (though less accurately). Now both F_{Ag} and F_I were determined before the discovery of isotopes and it occurred to the writer of this letter as early as 1940 that the facts (1) that iodine is isotopically pure and (2) that silver consists of two isotopes in nearly equal abundance might explain the F_I-F_{Ag} discrepancy.

In 1948, E. R. Cohen and the writer published[5] a least-squares analysis (here designated D and C '48) of the existing data on the atomic constants. Some eleven different precision measured values each representing a different function of the four unknowns, F, N_0, m, and h, formed the basic input data from which an overdetermined set of observational equations was adjusted by least-squares to obtain compromise output values of the above four unknowns. The adoption of four unknowns F, N_0, m and h (instead of three, $e(=F/N_0)$, m and h) for the least-squares adjustment (designated in the paper as the "new viewpoint") was a new departure in such analyses (expressly introduced because of the uncertainties in F) which led to a complete reclassification of several of the eleven input data. Other important influences beside the direct electrochemical data were thus free to operate in the least-squares adjustment leading to the output value of F. For the direct electrochemical data on F the average of F_{Ag} and F_I was used in D and C '48. The final least-squares-adjusted output value for F obtained from this analysis came out

$$F=9652.2\pm0.7 \text{ e.m.u./g (physical scale)}$$

in close agreement with F_I rather than F_{Ag}.

Largely because of this higher output value of F there has been a perhaps natural reluctance among some physicists to accept the revised values obtained in D and C '48 (some 33 values of different important constants and conversion factors were there computed). A chief purpose of this letter is to point out that the new corroboration from the work of Hipple and his associates now largely removes the cause of this reluctance. Also, since D and C '48 appeared, further evidence[6] in favor of the higher Faraday has been obtained as a by-product of a measurement[7] of the wavelength of the annihilation radiation.

Undoubtedly, the entire least-squares analysis should be repeated using the final Hipple value of F (when it is available) and perhaps ignoring F_{Ag} and F_I completely unless improvements can be made in these electrochemical determinations as regards at present unknown systematic errors. Although the results in D and C '48 were very insensitive to the directly measured x-ray value of h/e, it might also be wise to postpone such a final least-squares analysis until the h/e discrepancy (now under investigation at this Institute) can also be cleared up. In the meanwhile, the writer believes the values given in D and C '48 can now be provisionally used with considerably more confidence than heretofore.

* Assisted by the Joint Program of the ONR and AEC.

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A Note on the $Li^7(p,n)Be^7$ Reaction and an Excited State of Be^7

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BECAUSE of interest in the homogeneity of the neutrons produced in the $Li^7(p,n)$ reaction, we have re-examined data obtained two years ago with a Van de Graaff generator, using this reaction as a monoenergetic neutron source to study the resonance scattering of neutrons on helium.[1] In this experiment the neutrons crossed a proportional counter containing helium, and the energy distribution of the helium recoils was recorded. Since the neutron energies studied (0.8 to 1.6 Mev) were too low for significant *D*-wave scattering, the distribution curves should have been parabolas, corresponding to superposition of *S* and *P* waves. Instead, for all neutron energies used above 1.2 Mev (and for no lower energies), well-defined distortions in the curves were observed. From the largest recoil energy where distortion appears, one can calculate an excitation energy of Be^7, assuming that such a state has made the neutron beam di-energetic. The results are shown in Table I for all five curves where the effect was noted.

TABLE I. Implied excitation energy of Be^7.

Run	E_p	E_n	R	E_n'	E
1	3.02	1.25	0.63	0.78_5	0.45
2	3.02	1.25	0.63	0.78_5	0.45
3	3.12	1.35	0.57	0.76	0.54
4	3.12	1.35	0.64	0.87	0.45
5	3.38	1.6	0.70	1.13	0.44

(Three of these curves are shown in reference 1.) E_p is the energy in Mev of the Van de Graaff protons, E_n the energy of the main neutron group, R the ratio of recoil energy at the anomalous peak to maximum recoil energy, E_n' the energy of the postulated slower neutron group, and E the excitation energy of Be^7 which would cause such a group.

Table I shows that only one run was inconsistent with the excited state hypothesis, the location of the distorted peak was in fact exceptionally vague in this one case. While the anomalous peak cannot be localized sufficiently to give a precise measure of the excitation energy, the other four runs put it between 420 and 480 kev.

Recent precision measurements indicate that such a Be^7 state exists.[2,3] However, the excitation of this state by 3 Mev protons striking lithium has escaped previous observation.[4] The reason perhaps is that the Li(p,n) yield curve, which was studied by Freier, Lampi, and Williams, does not offer as sensitive a test as the helium recoil data, in which the slower neutrons at optimum energies produce resonant forward-scattered recoils which are superposed, in the distribution curves, upon non-resonant faster neutron recoils of unfavorable scattering angle. If the implications drawn from this helium data are correct, the traces of the slower neutron group should be observable in many neutron resonance studies, especially by comparing resonance data taken with both Li(p,n) and D(d,n) neutron sources.

As to helium scattering itself, in reference 1 the smallness of the ratio of maximum to minimum differential scattering cross sections in all of the curves was taken to indicate a split resonance level, but this apparently small ratio may also be due really to a slower neutron group.

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Fast Protons from the Absorption of π^--Mesons by Nuclei*

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By use of a very simple model for the production of stars resulting from the absorption of π^--mesons by nuclei it is possible to estimate (a) the number of "fast" protons (energy >30 Mev) in the stars, and (b) the average excitation energy. We assume that the meson is absorbed by a single proton in the nucleus producing a neutron which moves at high speed through a "gas" of nucleons, while momentum is conserved by the recoil of one or more neighboring nucleons. The fast nucleons may escape from the nucleus without collision or may undergo one or more collisions, thereby heating up the nucleus. Thus star fragments from π^--absorptions fall into two categories: high energy nucleons arising directly from the absorption process, and evaporation fragments whose energies are low and determined by the energy loss of the initial nucleon in traversing the nucleus. If the mean free path of the fast nucleons is of the order of or larger than the nuclear diameter, we would expect large numbers of fast nucleons as well as total excitation energies of the evaporation stars low compared to the meson rest mass of 146 Mev.

If, in addition to the collision cross section, the average energy loss per collision is known, one can estimate the probability that a nucleon makes a specified number of collisions before leaving the nucleus and the excitation energy of the residual nucleus. The energies involved are sufficiently high that, to a first approximation, the binding of the nucleons can be ignored. The total $n-p$ scattering $n-p$ scattering cross section is taken as $6.8/E$ barns where E is measured in Mev,[1] and we assume $\sigma_{nm}=\sigma_{p-p}=\frac{1}{4}\sigma_{n-p}$.[2] Since the nucleus is treated as a Fermi gas, the exclusion principle discriminates against collisions with small momentum transfer, thereby increasing the effective cross section by a factor of about 1.45.[3] The energy loss per collision has been estimated by Serber[4] as 25 Mev for energies of the order of 100 Mev. The calculation is greatly simplified by assuming forward scattering. The error involved is difficult to estimate, but is surely not very large and probably leads to a slight overestimate for the number of fast protons.

Two different models were used for the calculations.[5] I. The recoil momentum is taken up by a single nucleon so that the absorption results in two nucleons moving in opposite directions, each with half the meson rest energy. The recoil particle can be a neutron or a proton, and on the basis of an α-particle model the ratio of neutrons to protons is 2:1. Use of the ratio obtained by counting all neutrons and protons in the nucleus gives almost identical results. II. The recoil is a triton, the residual part of the α-particle of which the absorbing proton is taken to be a member. Using a triton binding energy of 8 Mev,[6] we find that the neutron carries away 95 Mev while the recoil triton has 31 Mev. The entire energy of the trition goes into heating up the nucleus.

With model I one calculates the probabilities that both nucleons make zero collisions, one makes one and the other zero, etc. After more than one collision the nucleon energy is degenerated below 30 Mev and is considered to be "lost" in the evaporation star. With model II the single nucleon is "lost" after more than two collisions. In this way one obtains an estimate of the number of absorptions which produce no stars (by star we mean evaporation star) and the number which yield fast protons. In all these calculations it is assumed that a charge exchange occurs in half the neutron-proton collisions.

The calculations were carried out for π^--absorptions in nitrogen and in silver so as to make possible a comparison with the observations in nuclear emulsions. The important results are given separately in Table I for nitrogen (taken as typical of the C, N, O group) and for silver (representing Ag, Br) since it should be possible experimentally to distinguish between the π^--stars produced in the light and heavy elements of the emulsion.

Evaporation stars of energy less than 40 Mev are classified separately since an excitation of that magnitude will produce stars consisting almost entirely of neutrons in nuclei as heavy as silver[7] and are therefore not observed. It is worth noting that model II

TABLE I.

	Model	Nitrogen	Silver
Number of fast protons ($E>30$ Mev) per 100 π^--mesons absorbed	I	48	24
	II	12	13
Average excitation energy of evaporation star	I	31 Mev	78 Mev
	II	55 Mev	70 Mev
Number of π^--absorptions giving no evaporation star (per 100)	I	28	8
	II	0	0
Number of evaporation stars with excitation <40 Mev per 100 π^--absorptions	I	31	12
	II	64†	43†

† The escaping fast nucleon is always a neutron.