the total cross section of the double Compton process due to the behavior near $\nu''=0$. This physically absurd result makes it clear that the large cross section for low frequency ν'' is obviously caused by a faulty application of the theory.

The present case of infra-red catastrophe appears to us particularly interesting because it seems likely that the deviation from the Klein-Nishina formula due to multiple processes may be measurable for hard gamma-rays passing through matter of low atomic number. Although every higher step adds a factor of 137 in the denominator of the cross sections, still the numerical factors present seem to make an observable effect not unlikely once a proper cut-off frequency has been determined.

We hope to report on our calculations in detail in the near future.

[1] C. J. Eliezer, Proc. Roy. Soc. **A187**, 210 (1946).
[2] W. Heitler, *Quantum Theory of Radiation* (Oxford, 1936), paragraph 18.

Magnetic Fields of Astronomical Bodies

Horace W. Babcock
Mount Wilson Observatory, Pasadena, California
June 7, 1947

On the assumption that magnetic fields in stars of approximately equal mass are proportional to their rates of rotation, I predicted early in 1946 that fields of the order of 1500 gauss should occur in certain early-type stars, and that the integrated Zeeman effect resulting from such stellar fields should be observable under certain conditions. Observations of 78 Virginis beginning in April of the same year, have confirmed this prediction,[1] and fields of the same general order of magnitude have since been observed in other stars. The strongest field observed to date is that of the peculiar A-type star BD—18°3789 (HD 125248); measures from two plates give a polar field of 5500 gauss. The polarity is opposite to that of 78 Virginis. I have been able to show further that, within the uncertainties of the observations, *the magnetic dipole moments of the earth, sun, and 78 Virginis* (8×10^{25}, 8×10^{33}, and 4×10^{36} gauss cm^3, respectively) *are proportional to their angular momenta* and may be obtained by multiplying the angular momenta, in c.g.s. units, by 10^{-15} gauss cm sec. g^{-1}. A paper discussing this and some other aspects of magnetism in astronomical objects is in press.[2]

If the foregoing relationship is of real physical significance, it may possibly apply also to the galaxy, and this is of some interest, partly on account of the influence of magnetic fields on cosmic rays. Actually, it is easier to apply it to our nearest neighboring galaxy, the Andromeda Nebula (M31), which, converging evidence shows, is essentially a twin of our own, and for which the rotation and mass have been measured more directly by spectrographic observation.[3] From the same measurements, we know that the greater part of the mass of M31 lies far from its center, and that to a first approximation we may regard it as a rather thin disk of uniform density rotating with a nearly constant angular velocity of 2.5×10^{-15} rad/sec. Its mass, a major portion of which must be dark material, is calculated to be 1×10^{11} times that of the sun; and the effective radius, within which lies most of the mass, may be taken as 6000 parsecs. If M31 has a magnetic moment proportional to its angular momentum, then, using the coefficient 10^{-15} gauss cm sec. g^{-1}, the moment is computed to be of the order of 10^{59} gauss cm^3, corresponding to a field of about 10^{-8} gauss parallel to the axis. Within the uncertainties of our knowledge, this should apply almost as readily to our galaxy as to the Andromeda Nebula.

It is probably unnecessary to add that the computed result for M31 is meaningless unless it is granted that the proportionality of magnetic moment to spin is a universal law, and that it is applicable to an assemblage of stars and dust in revolution as well as to single stars in rotation. Chapman[4] has objected to the view that terrestrial and solar magnetism are fundamental on the ground that the magnetic axes are inclined to the axes of rotation by about $11\frac{1}{2}$ degrees and 6 degrees, respectively, and that since at least a moderate component of the field seems not to be due to spin, it may be regarded as unlikely that any part of the field is due to a cause fundamentally related to gravitation.

[1] H. W. Babcock, Ap. J. **105**, 105 (1947).
[2] H. W. Babcock, Pub. Astro. Soc. Pac. **59**, 112 (June 1947).
[3] H. W. Babcock, Lick Observatory Bulletin **19**, 41 (1939).
[4] S. Chapman, Nature **124**, 19 (1929).

Method of Correcting Low Angle X-Ray Diffraction Curves for the Study of Small Particle Sizes

Jesse W. M. DuMond
California Institute of Technology, Pasadena, California
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A. Guinier in France has had considerable success[1] in the study of small particle sizes (and even their shapes) by means of low angle x-ray diffraction utilizing the reflection-type focusing, curved crystal spectrometer to obtain a monochromatic convergent beam of x-rays. The sample whose diffraction pattern is to be studied is placed in the convergent beam about midway between the curved crystal and the focus; the geometry of the arrangement is shown in Fig. 1. In reality the convergent beam is focused

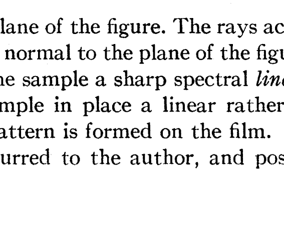

Fig. 1. Guinier's arrangement for the study of low angle x-ray diffraction.

only in the plane of the figure. The rays actually diverge in the direction normal to the plane of the figure so that in the absence of the sample a sharp spectral *line* is formed at *F*. With the sample in place a linear rather than a circular diffraction pattern is formed on the film.

It has occurred to the author, and possibly to others,[2]