ROSS GUNN'S ELECTROMAGNETIC THEORIES AND SOME COSMOLOGICAL PROBLEMS

C. E. VAN HORN
FISK UNIVERSITY, NASHVILLE

INTRODUCTION

The purpose of this paper is to present an exposition of Dr. Ross Gunn's Electromagnetic Theories (1929-1932) together with certain applications to problems in modern cosmogony. Dr. Ross Gunn is a young scientist in the service of the United States Naval Research Laboratory at Anacostia, D. C.

Modern ideas concerning the origin and evolution of the sidereal universe date from about 175 years ago when Kant pictured the primeval chaos as a spinning nebula from which the sun and planets were formed by condensation. Some forty years later Laplace revised and partially corrected Kant's notions. In consequence Laplace's Nebular Hypothesis became one of the landmarks in the history of stellar cosmogony. Though very imperfect it marked the beginning of a great series of labors whose objective has been and still is today the complete mathematical survey of the behavior of all types of masses of astronomical matter under varying dynamical conditions.

Hitherto this mathematical survey has been confined to a study of gravitational and thermal effects. And it is remarkable that such effects have been found to account for so many types of material configuration and for so many kinds of cosmic processes. Only recently have configurations and processes demanded that gravity and heat be supplemented by other forces as cosmic factors.

The significance of the researches of Dr. Ross Gunn lies in the fact that he is a pioneer in the study of these supplemental forces—in particular of electricity and magnetism as factors in the evolution of the sidereal universe.

Before beginning an exposition of Gunn's theories and their applications it may be well to mention briefly some discoveries that seem to demand a consideration of other forces in stellar processes besides gravity and heat. First of all systematic observations of the solar surface by Mount Wilson and other observers show that the sun possesses both an electric field and a magnetic field. Again the sun's rotation is highly anomalous. It varies with solar latitude. It varies with sun spot period and other variable physical features of the sun's constitution. A third discovery of importance is Struve's remarkable relation between observed high axial rotations in hot stars and their bright line spectra, developed in two papers of profound importance. A fourth discovery is that the periods of rotation and of revolution of spectroscopic binaries are identical. Other discoveries bearing on

the need of supplementing gravity and heat with other forces might be mentioned; but these four will be enough for the purposes of this paper.

Ross Gunn's Electromagnetic Theories

Dr. Ross Gunn is building up an extensive series of very interesting theories in cosmogony characterized by four principles to whose elucidation and illustration we now turn.

(1) *Every star possesses a radial electric field and a tangential magnetic field.* The following drawings (Fig. 1, *A.* and *B.*) illustrate the lines of force in the two fields. The modern electromagnetic theory of matter affords a partial basis at least for Dr. Gunn's first hypothesis. A star's electric field is easily accounted for in this way.

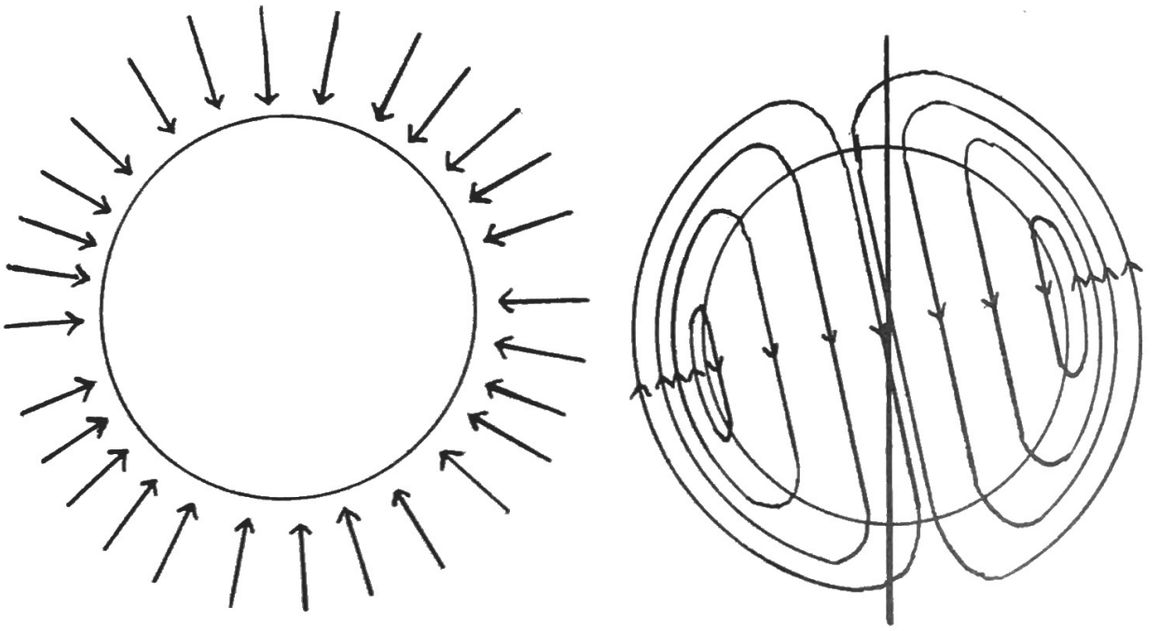

Fig. 1. To the left, the radial electric field of a star; to the right, the tangential magnetic field of a star.

Due to the extraordinarily high heat in a star's interior the outer electrons of all atoms are probably stripped loose, thus generating within the star masses of free electrons. These free electrons are carried up through and out of the upper layers of the star by convection processes. Now moving electrons are electric currents. Their radial motions account for the radial character of the electric field of a star. The magnetic field of a star is not easily accounted for; but the fact that our sun has one and that so small an astronomical body as our earth has one justifies the hypothesis that every star possesses one. The further feature that the magnetic axis may not coincide with the dynamical axis in a given star is not essential, but is not an unnatural one since this feature is present both in the earth and in the sun.

(2) *Every star possesses a highly ionized atmosphere permanently trapped and supported by the star's electromagnetic fields.* The masses of free electrons from a star's interior brought up by convection and discharged into its atmosphere do two things: They

generate the radial electric field already referred to, and they also ionize the atmosphere of the star. Moreover this ionized atmosphere of a star is permanently bound to it by the star's electromagnetic fields. This accounts for the known fact that rapidly rotating stars possess atmospheres. Even when the binding power of the gravitational field of a star is annulled by its rapid rotation, the binding power of its electromagnetic fields holds fast all the ionized portion of its atmosphere. This is also in line with Struve's remarkable relation referred to in the introduction.

(3) *Crossed electric and magnetic fields will produce in an ionic gas a mass movement that is independent of the masses and charges*

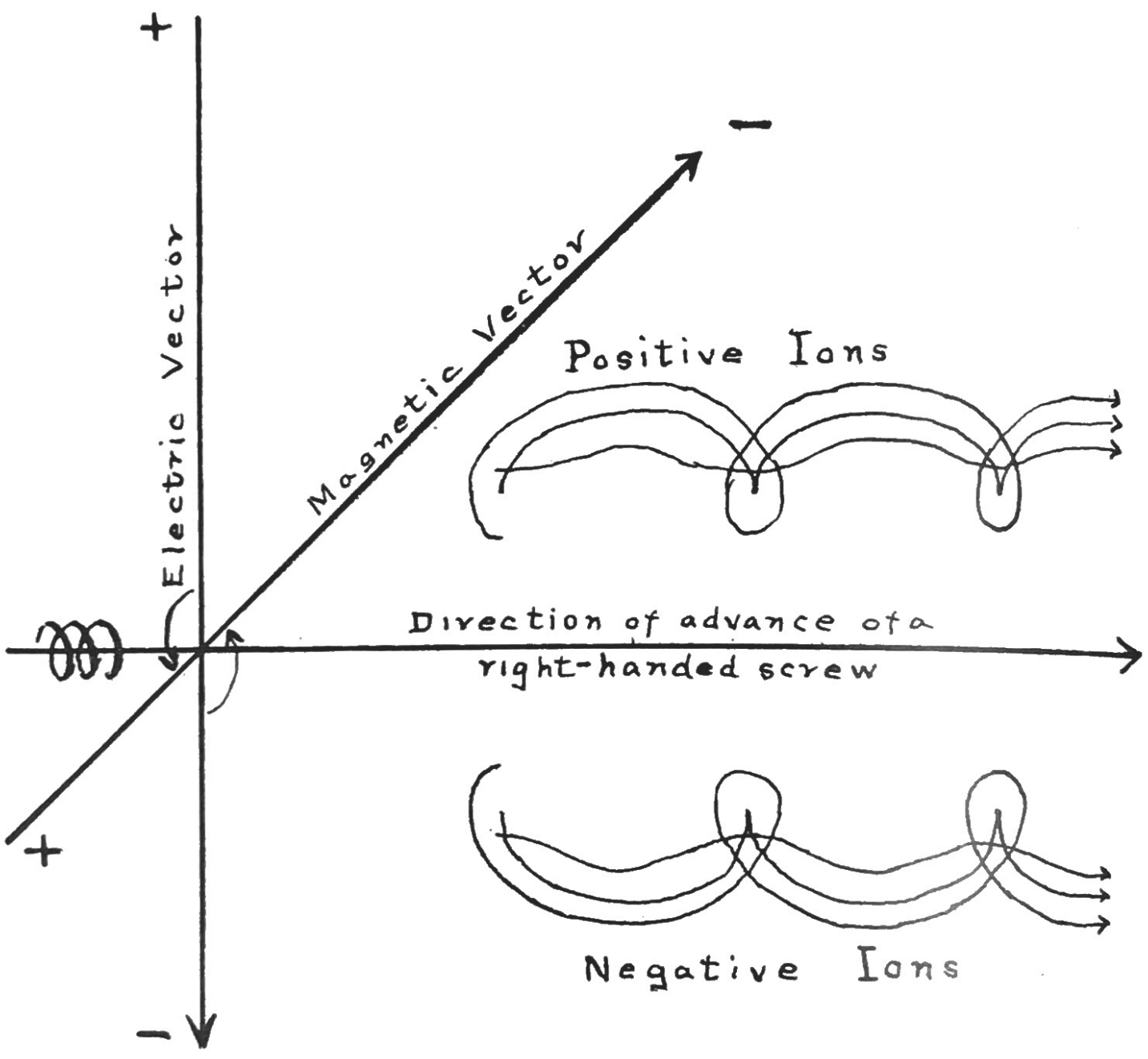

Fig. 2. The movement of ions in a crossed electric and magnetic field.

of the ions, the mass velocity being proportional to the ratio of the intensities of the electric and magnetic fields. In 1929, Leigh Page published a paper of profound importance for our purposes. In it he proved that a single ion subjected to crossed electric and magnetic fields advances in the direction of a right-handed screw in a cycloidal path with a velocity that is independent of its mass and charge. This result holds for the ions of any highly rarified ionic gas in which the ions possess long free paths (Fig. 2).

On the basis of Page's principle Dr. Gunn postulates the existence in the atmosphere of every star of vast systematic movements, or

"electromagnetic winds." This principle plays a profound role in Gunn's theories.

(4) *After fission each component of any divided star is thermally asymmetrical, and hence tends to act like a skyrocket.* The physical causes of fission will be dealt with below, but a star having divided, what are the conditions and behavior of the components? Fission causes interior portions of the original star suddenly to become exterior portions bringing with them their high internal heat. Moreover each component possesses certain portions of the star's original and relatively cool external surface. Thus each component of the divided star possesses a surface that is thermally asymmetrical. Let us now consider the behavior of one such component of a divided star. Its hotter portion of surface radiates energy more rapidly than the other portions. But radiant energy possesses inertia. Hence the hotter portion of its surface tends to "skyrocket" the component in question off into space. It is this last principle that has led the popular mind to apply the appellation "skyrocket" to Gunn's theories.

By means of these principles Gunn is throwing new light upon both old and new astronomical configurations and processes. In illustration of some of these applications the author will consider Gunn's theories of the relation between axial rotation and spectra of stars with special reference to the sun, and of the evolutionary origin of the solar system.

A star possessing an electric field, a magnetic field, and an ionized atmosphere may be considered. The crossed electric and magnetic fields generate an electromagnetic wind by the mechanism described under Gunn's third principle. At any moment this wind moves faster than the star's rate of rotation. Viscous drag tends to transfer momentum from the moving atmosphere to the star. Thus the star's rotation is systematically increased. Moreover and especially in the case of a highly energetic star, the electron streams that cause its electric field also cause a high degree of ionization in its atmosphere. Thus does Gunn account for Sturve's relation between high rotational velocity and highly enhanced spectra.

An application of these principles to the sun helps to account for the anomalies of its rotation. In the first place it explains the higher rate of rotation of the sun's atmosphere (at the equator about 29 days) as compared with its actual rate of rotation (31.8 days). At the equator the sun's atmosphere is moving eastward at the rate of about 1,100 miles per hour. At times of intense electronic discharge, as at sun spot maxima, the sun's electric field is intensified, and the rate of movement of its atmosphere is increased. Thus are the observed anomalies in the rotation of the sun's atmosphere explained by Gunn's theories.

The most important application of Gunn's principles is to the problem of the evolutionary origin of the solar system. Consider a star whose axial rotation is being systematically augmented by the

viscous transfer of momentum from its moving ionic atmosphere to its own motion. Due to the permanent trapping of its ionic atmosphere by its electric field and magnetic field the star's rotation will in time reach the critical rate for fission. Now fission is a stabilizing mechanism that transforms the angular momentum of the star's motion prior to fission into orbital momentum after fission, the two components revolving in orbits with the same faces toward each other. If the star's internal energy is sufficiently intense, the two components will "skyrocket" off to infinity relative to each other due to the thermal asymmetry of their surfaces.

Let Dr. Gunn speak for himself in the words of his paper on *The Evolutionary Origin of the Solar System* (1932, page 653):

> While the two components are very close to each other the remote and inner surface regions are necessarily in unstable equilibrium because, as Roche has shown, no body can be in stable equilibrium if that body is within 2½ radii of the tide raising star. . . . This is known as the Roche tidal limit. . . .
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> Thus when our parent star splits and the two component stars are very near to each other, and hence inside the Roche limit, the outermost and innermost surfaces disintegrate and masses are detached which are small compared to the masses of the primary. *These small masses are the planets.* Now before the planets can recede from the companion stars, they, too, break up as a result of centrifugal instability inside the Roche limit, and the planetary satellites are formed.

At the close of the paper quoted above Dr. Gunn says:

> If we have correctly traced the course of events and our solar system is in fact the result of a great rotational cataclysm that overtook the parent sun as a necessary consequence of the electromagnetic motions of its atmosphere, the solar system and the inhabitants of the system must indeed be part of a great evolutionary plan. Millions of binary star systems exist in the universe and the fission process must be very common. Planetary systems must be equally as numerous and we must conclude that conditions on many of them are similar to those existing on the earth.
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> Much labor and time must be spent before our account of the formation can be checked in all its details and a decision made as to its truth, but we have closely adhered throughout the theory to observed facts whenever they were available and supported each step by rough calculations. It seems quite clear that our mechanism is real and that the solar system did *not* originate as the result of a highly improbable accident as earlier investigators would have us believe, but came into being as the result of an orderly evolutionary process that we have reason to believe is quite common in the universe.

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