tered in the Philadelphia General Hospital. In addition, however, the new institute will hold itself ready to cooperate, aid and foster medical research by collaboration or affiliation with any or all medical and allied institutions desirous of establishing such a relationship.

Why, one may ask, is so much emphasis placed upon the need for medical investigation? Because experience has shown that progress in the past has come largely through this channel and because it is realized that investigation is essential for the better understanding of disease, its prevention and cure and for the better care of the sick. These various considerations constitute the sole object of the Philadelphia Institute for Medical Research.

Research in medicine in the past has come largely through contributions from universities, medical schools, their hospitals and clinics. More recently, because of urgent need, special institutions of research have been created in certain of the great cities in Europe and this country, the best known being the Pasteur Institute in Paris, the Rockefeller Institute for Medical Research in New York City, and one of quite recent date, the Thorndike Laboratory in the Boston City Hospital. All these institutes have made tremendous and permanent contributions to medicine, and added much to the welfare of mankind.

The Philadelphia Institute for Medical Research will occupy a somewhat analogous position to the Thorndike Institute and will concern itself with what is termed clinical investigation, *viz.*, the study of the sick and the diseases from which they suffer. Research will be made for methods of value for the prevention of disease, for improvements in methods of its study, and of diagnosis and treatment of disease, more especially in the earlier stages. Research will be prosecuted also in the fundamental branches of science underlying medical knowledge.

A pioneer feature of this new institute is the attempt to center and foster research through affiliation and collaboration with all medical institutions in Philadelphia, centering its efforts in the Philadelphia General Hospital.

In 1922 a group of Philadelphia physicians, realizing the supreme importance to humanity of research in medicine, arranged a centenary celebration of the birth of Pasteur, which led to the foundation of the Philadelphia Institute for Medical Research, the charter members of which were: Dr. William Duffield Robinson, Admiral William C. Braisted, Dr. Judson Daland, Dr. Frances X. Dercum, Dr. McCluney Radcliffe, Provost Edgar Fahs Smith, Dr. Charles A. E. Codman, Hon. Hampton L. Carson, Joseph Carson, Esq.

In establishing an institution of this kind, it is of the utmost importance to find a man to act as director, possessing the necessary knowledge, enthusiasm, training and proven ability to lead, in all questions concerning medical research. Such a man was found in the senior medical consultant and director of clinical investigation of the Mayo Clinic, Rochester, Minnesota, Dr. Leonard G. Rowntree, who will assume the duties of director at the opening of the institute in the fall of this year.

Plans are under way for the organization of the personnel of the institute.

A site, on the grounds of the Philadelphia General Hospital, has been assigned by the city council for the erection of a new building, at such time as funds become available. In the beginning, however, the institute will occupy temporary quarters in a new building now under construction, at the Philadelphia General Hospital, and will function in conjunction with the staffs of that hospital.

JUDSON DALAND,
President

PHILADELPHIA

QUOTATIONS

ON THE RELATION BETWEEN THE EXPANSION AND THE MEAN DENSITY OF THE UNIVERSE[1]

IN a recent note in the *Göttinger Nachrichten,* Dr. O. Heckmann has pointed out that the non-static solutions of the field equations of the general theory of relativity with constant density do not necessarily imply a positive curvature of three-dimensional space, but that this curvature may also be negative or zero. There is no direct observational evidence for the curvature, the only directly observed data being the mean density and the expansion, which latter proves that the actual universe corresponds to the non-statical case. It is therefore clear that from the direct data of observation we can derive neither the sign nor the value of the curvature, and the question arises whether it is possible to represent the observed facts without introducing a curvature at all.

Historically the term containing the "cosmological constant" λ was introduced into the field equations in order to enable us to account theoretically for the existence of a finite mean density in a static universe.

[1] Article by Professors A. Einstein and W. de Sitter in the *Proceedings* of the National Academy of Sciences for March. Communicated by the Mount Wilson Observatory, January 25, 1932.

It now appears that in the dynamical case this end can be reached without the introduction of λ.

If we suppose the curvature to be zero, the line-element is

$$ds^2 = -R^2(dx^2 + dy^2 + dz^2) + c^2dt^2, \quad (1)$$

where R is a function of t only, and c is the velocity of light. If, for the sake of simplicity, we neglect the pressure p,[2] the field equations without λ lead to two differential equations, of which we need only one, which in the case of zero curvature reduces to:

$$\frac{1}{R^2}\left(\frac{dR}{cdt}\right)^2 = \frac{1}{3}\kappa\rho. \quad (2)$$

The observations give the coefficient of expansion and the mean density:

$$\frac{1}{R}\frac{dR}{cdt} = h = \frac{1}{R_B}; \quad \rho = \frac{2}{\kappa R^2_A}.$$

Therefore we have, from (2), the theoretical relation

$$h^2 = \frac{1}{3}\kappa\rho \quad (3)$$

or

$$\frac{R^2_A}{R^2_B} = \frac{2}{3} \quad (3')$$

Taking for the coefficient of expansion

$$h = 500 \text{ km./sec. per } 10^6 \text{ parsecs}, \quad (4)$$

or

$$R_B = 2 \times 10^{27} \text{ cm.},$$

we find

$$R_A = 1.63 \times 10^{27} \text{ cm.},$$

or

$$\rho = 4 \times 10^{-28} \text{ gr. cm.}^{-3}, \quad (5)$$

which happens to coincide exactly with the upper limit for the density adopted by one of us.[3]

The determination of the coefficient of expansion h depends on the measured red-shifts, which do not introduce any appreciable uncertainty, and the distances of the extra-galactic nebulae, which are still very uncertain. The density depends on the assumed masses of these nebulae and on the scale of distance, and involves, moreover, the assumption that all the material mass in the universe is concentrated in the nebulae. It does not seem probable that this latter assumption will introduce any appreciable factor of uncertainty. Admitting it, the ratio h^2/ρ, or R^2_A/R^2_B, as derived from observations, becomes proportional to Δ/M, Δ being the side of a cube containing on the average one nebula, and M the average mass of the nebulae. The values adopted above would correspond to $\Delta = 10^6$ light years, $M = 2.10^{11}\odot$, which is about Dr. Oort's estimate of the mass of our own galactic system. Although, therefore, the density (5) corresponding to the assumption of zero curvature and to the coefficient of expansion (4) may perhaps be on the high side, it certainly is of the correct order of magnitude, and we must conclude that at the present time it is possible to represent the facts without assuming a curvature of three-dimensional space. The curvature is, however, essentially determinable, and an increase in the precision of the data derived from observations will enable us in the future to fix its sign and to determine its value.

REPORTS

SCIENCE ESSAYS BY HIGH SCHOOL PUPILS[1]

FINANCING THE VENTURE

THERE is a committee of the American Association for the Advancement of Science on the Place of Science in Education. One of the pieces of work in which this committee has engaged related to co-operation with teachers, pupils and librarians in secondary schools. In order to carry out the proposed venture special funds were necessary. Funds were secured as follows:

Commonwealth Fund, balance remaining from a previous grant	$ 417.48
American Association Executive Committee	500.00
Harry S. Bowers	1,200.00
Newcomb Cleveland	1,200.00
John W. Harris and John W. Hegeman	1,200.00
A. Cressy Morrison	600.00
Interest on funds in hand	273.53
Total	$5,391.01

All the clerical service was done in the office of the chairman of the Committee on the Place of Science in Education. The council of the American Association for the Advancement of Science has expressed its appreciation of the committee's work, and the council, the committee, high-school teachers, pupils

[2] It seems certain that the pressure p in the actual universe is negligible as compared with the material density ρ_0. The same reasoning, however, holds good if the pressure is not neglected.

[1] We continue to receive requests from schools wanting a repetition of the cooperative work with the A. A. A. S. Committee. It has not been possible to offer this opportunity again. Furthermore, certain types of unprofitable school contests have led to the conclusion that only those which can be designated as useful should receive encouragement from school authorities. We are entirely in sympathy with that policy.—The Committee on the Place of Science in Education.

[3] *Bull. Astronom. Inst. Netherlands, Haarlem,* 6, 142 (1931).