13. ______, *The category of categories as a foundation for mathematics*, Proc. Conf. on Categorical Algebra, Springer-Verlag, New York, 1966, pp. 1–21.

14. S. Mac Lane, *Categories for the working mathematician*, Springer-Verlag, New York and Berlin, 1971.

15. A. I. Mal'cev, *On the general theory of algebraic systems*, Mat. Sb. (N. S.) 35 (77) (1954), 3–20. (Russian)

16. E. G. Manes, *Algebraic theories*, Graduate Texts in Math., Springer-Verlag. New York, 1975.

17. ______, *Review of "Topological Transformation Groups. I,"* by J. de Vries, Bull. Amer. Math. Soc. 83 (1977), 720–731.

18. B. Mitchell, *Theory of categories*, Academic Press, New York, 1965.

19. A. Pultr and V. Trnková, *Full embeddings*, North-Holland, Amsterdam, 1978.

20. W. Taylor, *Residually small varieties*, Algebra Universalis 2 (1972), 33–53.

G. GRÄTZER

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General relativity for mathematicians, by R. K. Sachs and H. Wu, Graduate Texts in Mathematics, Springer-Verlag, New York, Heidelberg, Berlin, 1977, xii + 291 pp., $19.80.

The theory of general relativity is now more than sixty years old. During its formative years, the theory was a constant source of constructive interaction between mathematicians and physicists. Physicists drew heavily upon recent developments in differential geometry, and much research in differential geometry was stimulated by problems in general relativity. Many of the great physicists of the day (e.g., Einstein, Lorentz, Poincaré) were making fundamental contributions to mathematics, and many of the great mathematicians of the day (e.g., Cartan, Hilbert, Weyl) were making important contributions to physics. The years 1900–1930 marked a golden period in math-physics cooperation.

This pleasant state of affairs deteriorated, however, in the late 30s–early 40s. Mathematicians were moving toward a global viewpoint (manifolds, fiber bundles, cohomology) whereas physicists were content to work locally, doing all computations in a single coordinate system. Except for certain rather conjectural cosmological ideas, all the interesting physics (e.g. bending of light, perihelion precession, gravitational redshift, expansion of the universe) could be dealt with adequately without manifold theory. As the interests of geometers and relativists diverged, so of course did their languages. Differential geometers began to use invariant tensor notation and differential forms whereas physicists were content with classical tensor analysis, a language in which they were extremely fluent and which was quite adequate for the computations of interest to them. The years 1940–1970 marked a period of (comparatively) little interaction between geometers and physicists.

Now, in the 70s, the pendulum is swinging back. This is due largely to the fact that physicists have recently been applying global geometric techniques to obtain results of indisputable importance. One set of results (Hawking-Penrose [4]; see Penrose [6] for an account written for mathematicians) says that in any spacetime satisfying certain physically reasonable conditions