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Newman E & Penrose R. An approach to gravitational radiation by a method of spin coefficients. *J. Math. Phys.* 3:566-78, 1962.
[Univ. Pittsburgh, Pittsburgh, PA and Syracuse Univ., Syracuse, NY]

A new approach to general relativity by means of a tetrad or spinor formalism is presented. The essential feature of this approach is the consistent use of certain complex linear combinations of Ricci rotation coefficients which give, in effect, the spinor affine connection. It is applied to two problems in radiation theory; a concise proof of a theorem of Goldberg and Sachs[1] and a description of the asymptotic behavior of the Riemann tensor, for outgoing gravitational radiation. [The *SCI*® indicates that this paper has been cited over 425 times since 1962.]

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"For several years immediately following my PhD, I had been groping for a research program in the area of my thesis research, namely, in the general theory of relativity. The stimulation arising from a brief tour of some of the major European research centers, Hamburg, Copenhagen, London, and Dublin, had started me on a reformulation of the Einstein equations in terms of some new variables, the null tetrad vectors. Shortly after work on this program had begun, I received an invitation from my former thesis advisor Peter Bergmann to spend a year at Syracuse University. That began an extraordinarily stimulating period for me. Bergmann had gathered at Syracuse that year the very best of the young workers in relativity from around the world. There were Andrzej Trautman, Ivor Robinson, Engelbert Shucking, Ray Sachs, Arthur Komar, and

Roger Penrose. It turned out that Penrose was working on essentially the same problem as myself but from a slightly different, but much more powerful, point of view. Instead of working with a complex null tetrad system, as I had been doing, Penrose was using a pair of two-component spinor fields as the basic variables. Though the two reformulations were easily shown to be equivalent, the notational and calculational advantages of the spinor formulation were considerable. It was on this problem, and some applications of the reformulation (incidentally now known as the spin-coefficient or NP formalism) that the collaboration between Penrose and myself began, leading within the year to the above cited publication. (As an aside I would like to mention that this collaboration with Penrose has continued to the present.)

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"Though my memory is a bit hazy, I think we recognized quite early that we had done a fairly important piece of research and that there was considerable potential for further development. One of the things that impressed us was the ease with which we were able to prove or derive from our work already known results on gravitational radiation theory, as, for example, the Goldberg-Sachs theorem and the beautiful Bondi-Sachs[2,3] peeling theorem that had cost the original authors very great effort. The Einstein equations in their conventional version are composed of ten (very) nonlinear, second order partial differential equations for the ten components of the metric tensor which, except under conditions of high symmetry, are very difficult to solve. Our version contains over 30 equations for about 30 variables but our equations are all first order and are almost linear. Their power and utility seem to lie largely with 1) their first order nature, 2) their being so close to linear, and surprisingly 3) the large number of variables which allow special conditions to be easily imposed. More recent work is reported 'Asymptotically flat space-time.' "[4]

1. **Goldberg J N & Sachs R K.** A theorem on Petrov types. *Acta Phys. Pol.* 22(Suppl. 13): 13-23, 1962.
2. **Bondi H, Vanderburg M G J & Metzner A W K,** Gravitational waves in general relativity. VII. Waves from axi-symmetric isolated systems. *Proc. Roy. Soc. London A* 269:21-52, 1962.
3. **Sachs R K.** Gravitational waves in general relativity. VIII. Waves in asymptotically flat space-time. *Proc. Roy. Soc. London A* 270:103-26, 1962.
4. **Newman E T & Todd K P.** Asymptotically flat space-time. (Held A, ed.) *General relativity and gravitation.* New York: Plenum, 1980. Vol. 2. p. 1-36.