WHITEHEAD'S GTR

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A NEW PERSPECTIVE BY K. STRANG

General Theory of Relativity: Whitehead's competing theory based on electromagnetism

'According to Whitehead, the Maxwell-Lorentz theory of electrodynamics (unlike Einstein's GTR) could be conceived as coherent with our basic intuitions—even in its four-dimensionalformat, namely, by elaborating Minkowski's electromagnetic worldview. Hence, Whitehead developed his ATG [Alternative Theory of Gravity] in close analogy with the theory of electrodynamics. He replaced Einstein's geometric explanation with an electrodynamics-like explanation. Whitehead explained the gravitational motion of a free mass-particle asdue to a field action determined by retarded wave- potentials propagating in a uniform space-time from the source masses to the free mass-particle.

It is important to stress that Whitehead had no intention of improving the predictive content of Einstein's GTR, only the explanatory content. However, Whitehead's replacement of Einstein's explanation with an alternative explanation entailed a replacement of Einstein's formulae with alternative formulae; and these different formulae implied different predictions. So it would be incorrect to say that Whitehead's ATG is empirically equivalent to Einstein's GTR. What can be claimed, however, is that for a long time Whitehead's theory was experimentally indistinguishable from Einstein's theory.

In fact, like Einstein's GTR, Whitehead's ATG leads to Newton's theory of gravitation as a first approximation. Also (as shown by Eddington in 1924 and J. L. Synge in 1952) Einstein's and Whitehead's theories of gravitation lead to an identical solution for the problem of determining the gravitational field of a single, static, and spherically symmetric body—the Schwarzschild solution. This implies, for example, that Einstein's GTR and Whitehead's ATG lead to the exact same predictions not only with respect to the precession of the perihelion of Mercury and the bending of starlight in the gravitational field of the sun (as already shown by Whitehead in 1922 and William Temple in 1924) but also with respect to the red-shift of the spectral lines of light emitted by atoms in the gravitational field of the sun (contrary to Whitehead's own conclusion in 1922, which was based on a highly schematized and soon outdated model of the molecule). Moreover (as shown by R. J. Russell and Christoph Wassermann in 1986 and published in 2004) Einstein's and Whitehead's theories of
gravitation also lead to an identical solution for the problem of determining the gravitational field of a single, rotating, and axially symmetric body—the Kerr solution.

Einstein's and Whitehead's predictions become different, however, when considering more than one body. Indeed, Einstein's equation of gravitation is non-linear while Whitehead's is linear; and this divergence qua mathematics implies a divergence qua predictions in the case of two or more bodies.

For example (as shown by G. L. Clark in 1954) the two theories lead to different predictions with respect to the motion of double stars. The predictive divergence in the case of two bodies, however, is quite small, and until recently experimental techniques were not sufficiently refined to confirm either Einstein's predictions or Whitehead's, for example, with respect to double stars. In 2008, based on a precise timing of the pulsar B1913+16 in the Hulse-Taylor binary system, Einstein's predictions with respect to the motion of double stars were confirmed, and Whitehead's refuted (by Gary Gibbons and Clifford Will).

The important fact from the viewpoint of the philosophy of science is not that, since the 1970s, now and again, a physicist rose to claim the experimental refutation of Whitehead's ATG, but that for decades it was experimentally indistinguishable from Einstein's GTR, hence refuting two modern dogmas. First, that theory choice is solely based on empirical facts. Clearly, next to facts, values— especially aesthetic values—are at play as well. Second, that the history of science is a succession of victories over the army of our misleading intuitions, each success of science must be interpreted as a defeat of intuition, and a truth cannot be scientific unless it hurts human intuition. Surely, we can be scientific without taming the authority of our intuition and without engaging in the disastrous race to disenchant nature and humankind.'

[Stanford Encyclopedia of Philosophy by Ronald Desmet and Andrew David Irvine https:// plato.stanford.edu/entries/whitehead/]

(Note: For a more detailed account of Whitehead's involvement with Einstein's STR and GTR, cf. Palter 1960, Von Ranke 1997, Herstein 2006 and Desmet 2011, 2016b, and 2016c.)