

How the green light was given for gravitational wave search

Paweł Nurowski

Centrum Fizyki Teoretycznej PAN w Warszawie

The recent detection of gravitational waves by the LIGO/VIRGO team is an incredibly impressive achievement of experimental physics. It is also a tremendous success of the theory of General Relativity. It confirms the existence of black holes; shows that binary black holes exist; that they may collide and that during the merging process gravitational waves are produced. These are all predictions of General Relativity theory in its fully nonlinear regime.

The existence of gravitational waves was predicted by Albert Einstein in 1916 within the framework of linearized Einstein theory. Contrary to common belief, even the very definition of a gravitational wave in the fully nonlinear Einstein theory was provided only after Einstein's death. Actually, Einstein had arguments against the existence of nonlinear gravitational waves (they were erroneous but he did not accept this), which virtually stopped development of the subject until the mid-1950s. This is what we refer to as the Red Light for gravitational waves research.

In the following years, the theme was picked up again and studied vigorously by various experts, mainly Herman Bondi, Felix Pirani, Ivor Robinson and Andrzej Trautman, where the theoretical obstacles concerning gravitational wave existence were successfully overcome, thus giving the 'Green Light' for experimentalists to start designing detectors, culminating in the recent LIGO/VIRGO discovery.

In this lecture we tell the story of this theoretical breakthrough. Particular attention will be given to the fundamental 1958 papers of Trautman, which seem to be lesser known outside the circle of General Relativity experts. The talk will be based on the article of C. Denson Hill and PN [1] published in the special volume of Notices of the American Mathematical Society devoted to gravitational waves detection.

[1] C. D. Hill, P. Nurowski, Notices of AMS **64**, 686 (2018), <http://www.ams.org/journals/notices/201707/>.