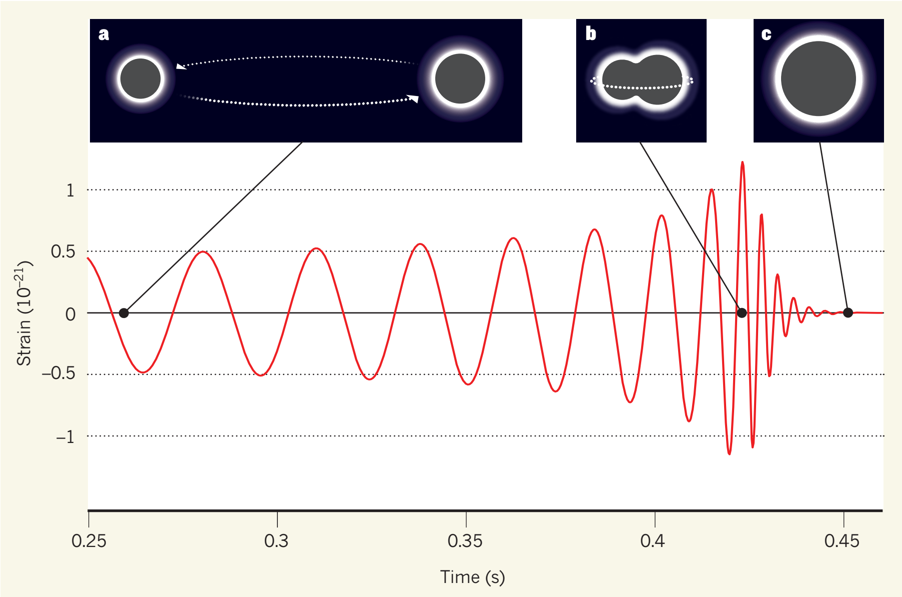

Figure 1 | A gravitational wave from merging black holes. Abbott *et al.*[3] report the detection of a gravitational wave, which they attribute to the coalescence of two black holes. **a**, The wave was first detected at approximately 35 Hz, as it reached the sensitivity range of Advanced LIGO (the detecting observatory). At this point, the black holes were spiralling in towards each other. The depicted radii are proportional to the black-holes' masses. **b**, The wave frequency increased as the black holes coalesced — at the point of merger, the black-hole horizons overlapped, but had not settled down to their final state. **c**, The wave dissipated as the merged black hole attained its final, simple configuration. The wave depicted here is based on observational data, but has been smoothed and fitted to a numerical model based on general relativity; strain represents the fractional changes in distance that are produced by the waves. (Adapted from ref. 1.)

is still only about 2×10^{-6}. Previous tests of general relativity have therefore been restricted to systems that have weak gravity.

But at the event horizon of a black hole (the boundary beyond which nothing can escape the hole's gravitational field), GM/Rc^2 is roughly 1, many orders of magnitude larger than for planets and stars. Gravity can thus be tested directly at its greatest strength for the first time, by analysing GW150914 and any other signals detected for similar mergers in the future. General relativity has passed the tests set by GW150914 with flying colours[4]. This signal has also provided the most direct confirmation yet of the existence of event horizons, which are unique to black holes.

The discovery of GW150914 has profound consequences for astronomy. Previously known black holes that formed from a single star have quite a restricted mass range: the highest mass that was definitively established was found to be only about 15 times the mass of the Sun[5]. Analysis of GW150914 has doubled this mass record at a stroke (the merging black holes had masses 29 and 36 times that of the Sun[6]), and then doubled it again (the final merged black hole is inferred to have a mass 62 times that of the Sun[6]). The spins of black holes are notoriously difficult to measure, but Abbott *et al.* were able to infer the spin of the final black hole from their data: the 160-kilometre-radius black hole spins completely around 100 times per second, which is roughly 70% of the maximum possible rate for a black hole of this mass.

None of this could have happened without spectacular developments in instrumentation. Gravitational waves distort space and time only slightly at our distance from any likely sources. The distortion is characterized by a dimensionless quantity called strain, which is the fractional change in distances produced by the waves. Even for a fairly strong event such as the black-hole merger, the change is tiny: the authors find a maximum value of just 10^{-21}. This means that the 4-kilometre-long, L-shaped arms of Advanced LIGO change in length by about 1/200 of the radius of a proton. Such changes can nonetheless be seen because of the exquisite precision of the optics of Advanced LIGO, the delicacy of its suspension and the power of its lasers, which all result from years of development — the LIGO detector has improved in all respects by orders of magnitude since its first conception more than 40 years ago.

Even more encouragingly, further major improvements are just around the corner. During its next run in 2016, Advanced LIGO will be able to observe about three times the volume of space that it could in 2015, and in the next year or two the Advanced Virgo detector in Italy will join the search for gravitational waves. A few years later, the Japanese Kamioka Gravitational Wave Detector will come online, and it is hoped that LIGO-India will join the hunt before 2025. This international network will also benefit from technological developments in light manipulation such as those at the GEO600 detector in Germany. The

NATURE

50 Years Ago

The dilatory attitude of the Committee on Libraries set up by the University Grants Committee and the Ministry of Education, and the naïve remark in the Robbins Report that "a library adequate to scholarly research is as essential to the efficient running of a university as an adequate range of computers", fully justifies the anxiety expressed recently by the Master of Sidney Sussex College, Cambridge … Universities, as Dr. D. Thomson pointed out, have managed for centuries without computers, but never without libraries.
From *Nature* 5 March 1966

100 Years Ago

We notice in *La Geographie* for November, 1915, that the hydrographic department of the French Admiralty have replaced the German names in Kerguelen by names of French origin. It must be very galling to the French to see an abundance of German names scattered over the chart of their Antarctic island, especially as German explorers were never very sparing in their naming … however, the practice of changing established names is a dangerous one if carried far, and it is to be hoped … this principle will not be applied indiscriminately, for confusion would certainly be the result.

ALSO:
Those who are inclined to doubt whether museums play any useful part in war-time should read the account of what is being done in the Leicester Museum, by means of an Infant Welfare Exhibition, to combat the appalling mortality among infants … This mortality, which is largely preventable, is brought out with startling vividness by means of a series of wooden columns, that for infants up to twelve months old standing no fewer than 11 ft. high, while that for the death-rate between the ages from five to twenty is but 2¾ of an inch high.
From *Nature* 2 March 1916