

# Triumph for gravitational wave hunt

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based on self-titled article by Adrian Cho from Science, 12 Feb 2016

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# Agenda

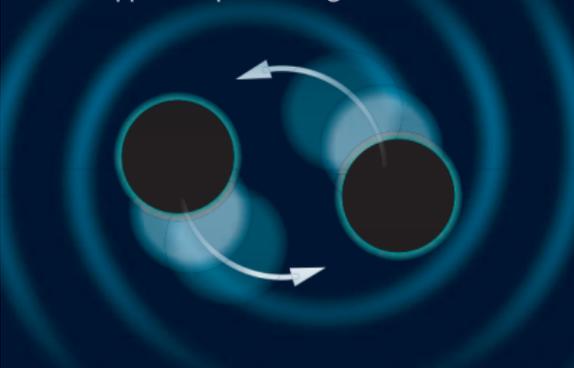
- What the gravitational waves are?
- How do we detect them?
- How the discovery was made?
- What it leads to?

# Gravitational waves

- Ripples in the fabric of space and time
- Predicted by Albert Einstein 100 years ago
- Very weak
- Emerge when two black holes collide

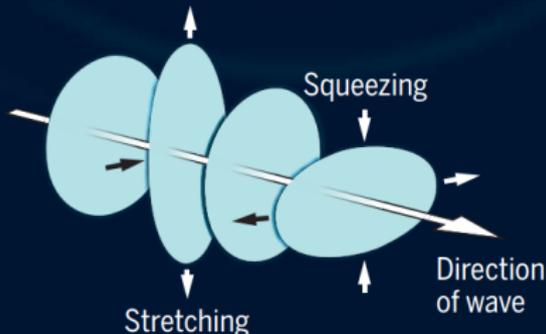
## Birth

As Einstein calculated, a whirling barbell-shaped mass, such as two black holes spiraling together, radiates ripples in spacetime: gravitational waves.



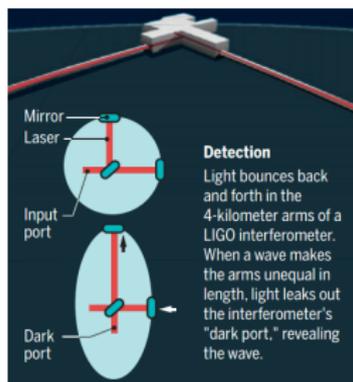
## Space travel

Zippering along at light speed, a wave stretches space in one direction and squeezes in the perpendicular direction, then reverses the distortions.



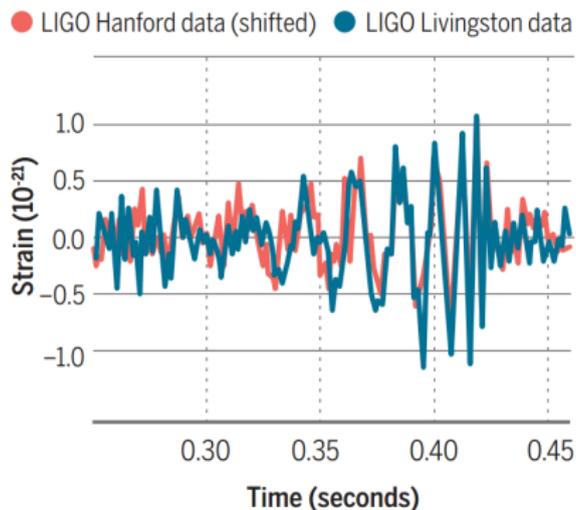
# Means for detecting

- Laser Interferometer Gravitational-Wave Observatory (LIGO)  
— Washington and Louisiana, USA
- 2 L-shaped interferometers with arms 4 km long
- Very precise:  $\approx 10^{-19} m \approx \frac{1}{10000}$  the width of proton



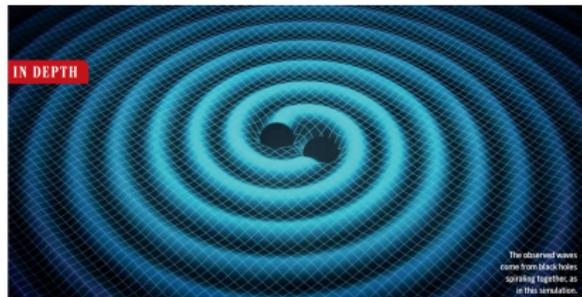
# The observation

- 14 September 2015, 9:50:45 UTC
- Duration — 0.25 sec
- Frequency — from 35 to 250 Hz
- Delay — 0.007 sec



# The observation — calculations

- Two black holes collided 1.3 billion years ago
- Their masses were  $29m_{\odot}$  and  $36m_{\odot}$
- Final black hole weighs  $62m_{\odot}$
- The difference ( $3m_{\odot}$ ) vanished in gravitational radiation
- "For a tenth of a second a collision shines brighter than all of the stars in all the galaxies"



## Meaning of the discovery

- Proof of gravitational waves' existence
- Very precise test of Einstein's general theory of relativity
- Undeniable evidence for black holes

# Summary

- Gravitational waves
- Means for detecting
- The observation
- Meaning of the discovery

# Conclusion

- Significant scientific discovery
- Likely to win the Nobel Prize