The First Gravitational Wave Catalog, GWTC-1

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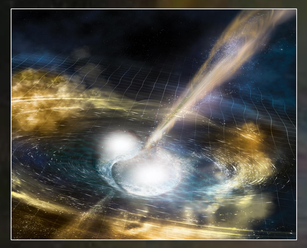
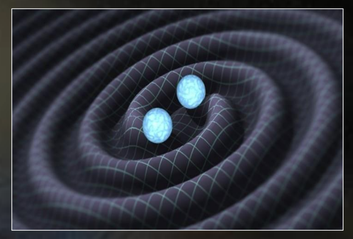
What are Gravitational Waves (GWs)? Cosmic earthquakes!



A. GWs from the collision of Neutron stars

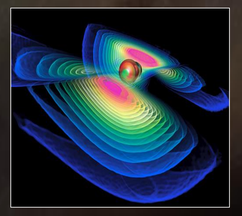
- Ripples in space and time. caused when extremely heavy objects move extremely fast.
- Similar to how objects dropped in water make waves



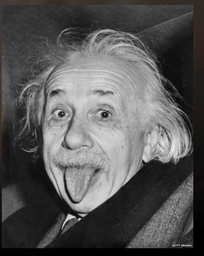
B. GWs from the inspiral of two neutron stars

Why study GWs? Unraveling the mysteries of gravity!

C. Binary Black Holes



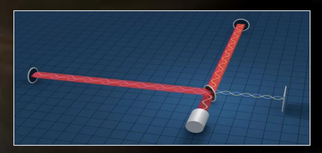
D. GWs from the Big Bang



E. Einstein said so!

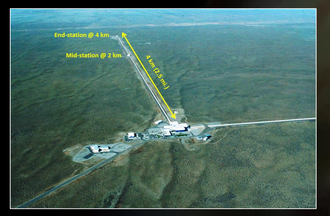
- GWs pass unperturbed through matter.
- Only known way to observe Black Holes
- Study the structure of Neutron Stars
- "Hear" the big bang!

How do we detect GWs? Massive Lasers!



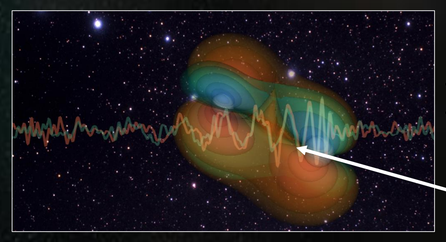
F. LIGO Cartoon

- GWs stretch and squeeze spacetime.
- Lasers are sensitive to length changes.



G. LIGO Top view

How do we model and analyze GWs? Supercomputers

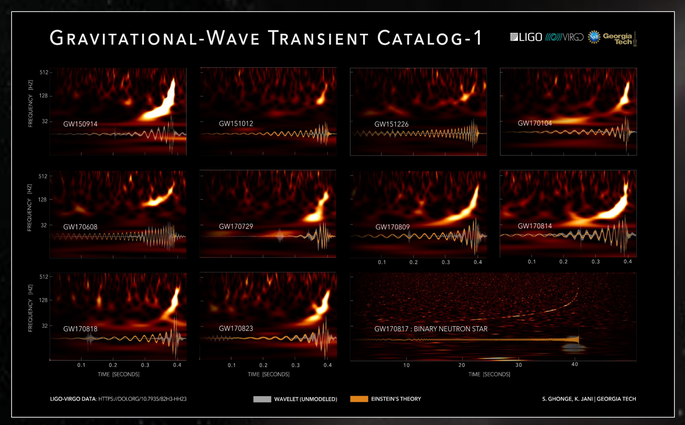


H. Simulation of colliding black holes

GaTech simulation

- Simulate GWs on supercomputers at Georgia Tech
- Analyze data from LIGO and Virgo using supercomputers at Georgia Tech

Heard a Gravitational Wave (GW) lately? We heard 11!

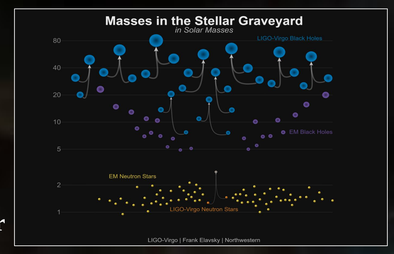


- First Catalog of Gravitational Wave events.
- Each Black Hole between 10 to 50 times as massive as the sun.!

I. Time Frequency maps of 10 Binary Black Hole + 1 Binary Neutron Star collisions.

Conclusions and impact. We now know how Gold is made!

- First set of direct observation of Black holes!
- Binary Neutron star kilonova confirms nucleosynthesis of heavier elements like gold.



J. Masses of detected Black Holes and Neutron Stars

K. GW170817: Binary Neutron star collision is most widely observed cosmic event in history.

Acknowledgements: LIGO Labs, CRA – GaTech, Northwestern University, Sonoma State University

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