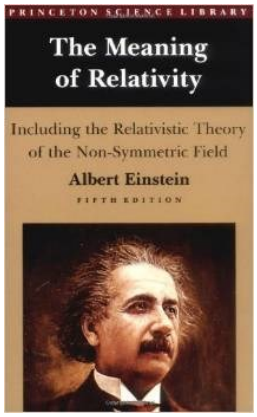
Credits and Research

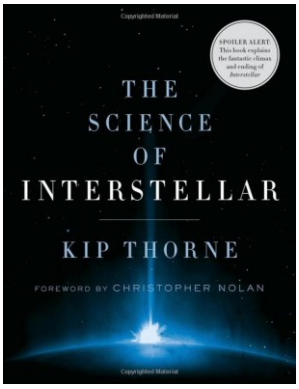
Here's the list of sources I used to put together the "How fast is it" video book. These books, videos and websites also represent resources you can use to do further research.

[Music: *Hans Zimmer – S.T.A.Y. - Interstellar: Original Motion Picture Soundtrack 2014***]**

Books

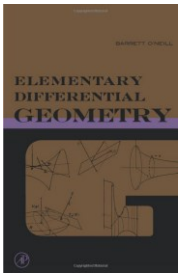


"The Meaning of Relativity" is Einstein's own book on the subject. It's a worthwhile read even if you don't do the math.

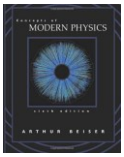


Kip Thorne's book "The Science of Interstellar" covers the science behind the movie. It's a great resource for understanding Black Holes.

"Elementary Differential Geometry" by Barrett O'Neill was the textbook I used at San Diego State University. It is well written and covers the foundations in geometry needed for a deeper understanding of General Relativity.



Another good college textbook is "Concepts of Modern Physics" by Arthur Beiser.



Special Places

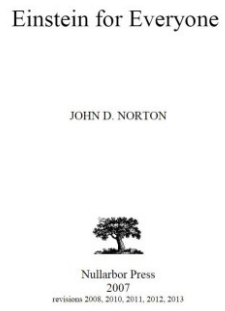
Here are two sources that are particularly useful for learning about Relativity Theory.

STANFORD
UNIVERSITY

One of them is the Stanford University YouTube series on the subject presented by Leonard Susskind. I used it extensively. But it assumes a deep understanding of the math.

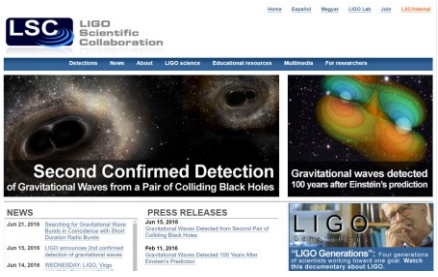
https://www.youtube.com/watch?v=toGH5BdgRZ4

Better yet, for those who are not familiar with differential equations, Dr. John D. Norton's website is outstanding. Norton has a deep understanding of the subject matter and discusses it in non-mathematical terms. I used his examples extensively.



http://www.pitt.edu/~jdnorton/teaching/HPS_0410/index.html

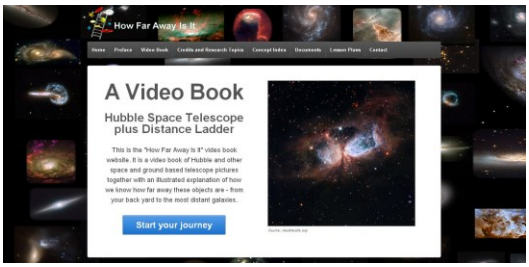
For Gravitational waves, there is no better source than the LIGO site itself as well as the associated Caltech/MIT site. They have created resource usable by everyone from middle school to post-doctoral students. It also has an outreach facility for teachers.

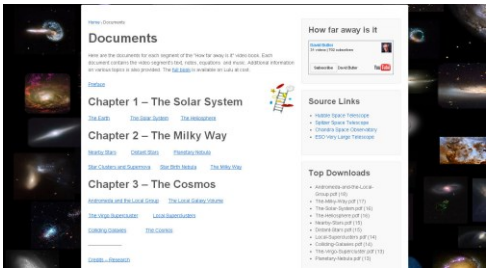


www.ligo.org

www.ligo.caltech.edu

And don't forget, every How Far Away Is It video segment, including these have a document with the text, links, music, pictures and notes located on howfarawayisit.com/documents





The following identifies all my sources. Thanks for watching.

Websites

Animal speed records

http://www.pbrc.hawaii.edu/~petra/animal_olympians.html

List of vehicle speed records

http://en.wikipedia.org/wiki/List_of_vehicle_speed_records

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Time dilation

http://arstechnica.com/science/2014/09/time-dilation-measured-at-40-percent-of-the-speed-of-lightin-the-lab/

Time Dilation and Spacecraft

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An atomic clock is used for precise time-stamping, which in fact allows controllers to see the time dilation effects from Einstein's Theory of General Relativity.

http://en.wikipedia.org/wiki/Error_analysis_for_the_Global_Positioning_System

Cosmic ray muons and relativistic time dilation

https://teachers.web.cern.ch/teachers/archiv/hst2000/teaching/expt/muoncalc/lifecalc.htm

Water waves - Dan Russell 2011

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Aircraft – and the sound barrier

http://www.newworldencyclopedia.org/entry/Sound_barrier#Early_problemsOf

Waves and Light

http://www.mrsciguy.com/Physics/Waves.html

How did we find out about the Speed of Light-Isaac Asimov

https://docs.google.com/document/d/1ha9_i8JaSG2ucmvd1uQh1utsj2x7S-FKpYh1QZEwYEQ/edit#heading=h.wmmlc9x44g1m

The Technical Services Group at MIT's Department of Physics

http://tsgphysics.mit.edu/front/

Cesium Atoms at Work

http://tycho.usno.navy.mil/cesium.html

This is called space contraction.

http://www.nasa.gov/exploration/systems/orion/index.html

L-Space Excursions Spaceship

http://slybrarian.livejournal.com/25136.html

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The Mossbauer Effect

http://www.ajaja.paradoxinc.org/Physics/The-Effects/Mossbauer/Mossbauer.html

Harvard Tower Experiment

http://hyperphysics.phy-astr.gsu.edu/hbase/relativ/gratim.html

The Experiment of Rebka and Pound (an excellent online book on physics)

http://www.relativity.li/en/epstein2/read/i0_en/i4_en/

On The Science of Interstellar – an excellent article on Kerr metric and Gargantua

http://relativitydigest.com/2014/11/07/on-the-science-of-interstellar/

Thomas A Moore – A General Relativity Workbook (a very well put together written coverage of General Relativity)

http://www.physicspages.com/index-physics-relativity/thomas-a-moore-a-general-relativity-workbook/

Parsing the Science of Interstellar with Physicist Kip Thorne

http://blogs.scientificamerican.com/observations/parsing-the-science-of-interstellar-with-physicist-kip-thorne/

An article detailing the science of Interstellar:

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http://hyperphysics.phy-astr.gsu.edu/hbase/forces/gravwav.html

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http://hubblesite.org/newscenter/archive/releases/2016/17/

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http://astrogravs.gsfc.nasa.gov/docs/catalog.html

Gravoscope allows you to overlay the projected possible locations of gravitational waves detected by Advanced LIGO

http://astrog80.astro.cf.ac.uk/Gravoscope

Source galaxy count (up to 7 x10^4)

http://physics.stackexchange.com/questions/235593/how-many-galaxies-could-be-the-source-of-the-recent-ligo-detection

How to find source direction from receiver timing

http://www.wired.com/2016/02/ligo-aint-gravitational-wave-detector-observatory

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University of Cambridge, Institute of Astronomy

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Christopher Berry – Gravitational Wave Astronomer

https://cplberry.com/category/equation-free/

Joe Webber blog

https://writescience.wordpress.com/tag/joe-weber/

Australian astrophysicist Katie Mack will answer your – and our – questions

https://www.theguardian.com/science/live/2016/feb/12/gravitational-waves-an-astrophysicist-answers-your-questions-live

LIGO Website

GW150914: Factsheet

http://ligo.elte.hu/detections/GW150914-FactSheet.pdf

Ligo Vibration Isolation

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Caltech and MIT on Ligo detection

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LIGO Flyer

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Source sky location picture

Image Credit: LIGO/Axel Mellinger

More LIGO links

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National Geographic's World's Deadliest - Fastest Animal Makes a Kill

https://www.youtube.com/watch?v=r7lglchYNew

Mike Theiss UltimateChase.com YouTube video

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Thrust SSC Supersonic Boom

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Air is an elastic medium and sound is a disturbance that moves through it.

https://www.youtube.com/watch?v=jXSaEnM3wWg

The X-1 Program: Chuck Yeager Exceeding the Speed of Sound; 1947 USAF Archive Films

https://www.youtube.com/watch?v=KNcIkTQEadE

SR-71 Blackbird - Speed: Mach 3+

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Fastest Aircraft in the World - X-15 Rocket Jet Flight - 4,500 MPH Space Plane

https://www.youtube.com/watch?v=TR5SYp948kw

APOLLO 10 launch: "Relive this fantastic launch on TV", ABC News coverage, May 18, 1969

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SpaceX Rocket Launch

https://www.youtube.com/watch?v=rFDh3E6wxx8

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Michelson Interferometer

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3D HD Star Wars Jump to light speed

https://www.youtube.com/watch?v=uvnk9dcqVbA

Traveling Speed of Light Backwards

https://www.youtube.com/watch?v=rjfVjD_hRG4

NASA Mars Science Laboratory (Curiosity Rover) Mission Animation

https://www.youtube.com/watch?v=gwinFP8_qIM

What's a Tensor?

https://www.youtube.com/watch?v=f5liqUk0ZTw

Tensor Calculus 0: Introduction

https://www.youtube.com/watch?v=e0eJXttPRZI

GPS & Relativity

https://www.youtube.com/watch?v=zQdIjwoi-u4

Precession by gyro top

https://www.youtube.com/watch?v=sHnDzGWcqlQ

Interstellar – Building a Black Hole – Official Warner Bros.
https://www.youtube.com/watch?v=MfGfZwQ_qaY

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Lee C. Loveridge, February 4, 2008

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"Observation of Gravitational Waves from a Binary Black Hole Merger" B. P. Abbott et al.* (LIGO Scientific Collaboration and Virgo Collaboration) (Received 21 January 2016; published 11 February 2016)

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"Deflection of Light by the Earth" Andrew Gould – Institute for Advanced Study, Princeton NJ 08540

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Rodney A. Brooks, "Fields of Color: The theory that escaped Einstein" Epic Publications 2010

Stephen Hawking, "The Universe in a Nutshell" Bantam 2001

Arthur Beiser, "Perspectives of Modern Physics" McGraw-Hill 1969

Jerry B. Marion, "Classical Dynamics of Particles and Systems" Academic Press 1970

Richard T. Weidner & Robert L. Sells, "Elementary Modern Physics" Allyn and Bacon, Inc. 1969

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https://www.animations.physics.unsw.edu.au/jw/light/speed-of-light.htm#:~:text=The%20speed%20of%20light%20is,measured%20speed%20of%20radio%20waves

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Title: Sirius B and the gravitational redshift - an historical review
Authors: Hetherington, N. S.
Journal: Royal Astronomical Society, Quarterly Journal, vol. 21, Sept. 1980, p. 246-252.
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How Far Away Is It - 06 - Distant Stars (4K)

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https://research.ast.cam.ac.uk/lensedquasars/index.html
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A precise extragalactic test of General Relativity

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https://aasnova.org/2017/01/20/the-search-for-lensed-supernovae/

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A merger in the dusty, $z = 7.5$ galaxy A1689-zD1?
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