



Credits and Research

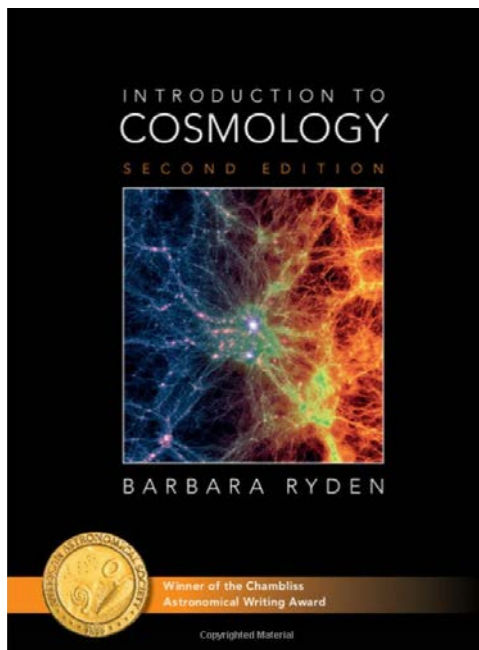
Here's the list of sources I used to put together the "How old is it" video book. These books, videos, and websites also represent resources you can use to do additional research into areas touched on in this video book.

[Music: Puccini - Tosca - E lucevan le stelle]

I used the YouTube Stanford University Cosmology Lectures 1 through 10 (January 14, 2013) by Leonard Susskind extensively. He introduces the study of Cosmology and derives the classical physics formulas that describe our expanding universe. It's the best out there.



<https://www.youtube.com/watch?v=P-medYaqVak>



Here is the book I used extensively. The author puts it all together in a very logical order that is easy to follow. But it does have a lot of calculus level math.



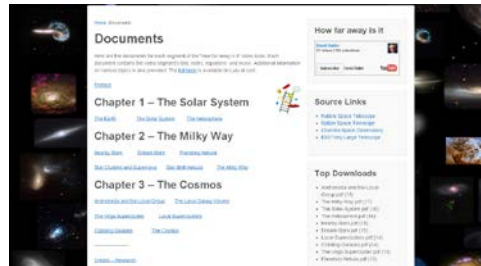
Ned Wright's Cosmology Tutorial

And don't miss Ned Wright's cosmological tutorial site. It is the best site for basic information presented in a straight forward way. His FAQ page is absolutely outstanding.



<http://www.astro.ucla.edu/~wright/cosmolog.htm>

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



The following identifies all my sources.

Thanks for watching.

Videos

Stanford University Cosmology Lectures 1 through 10 (January 14, 2013) by Leonard Susskind

<https://www.youtube.com/watch?v=P-medYaqVak>

4K explosion

<https://www.youtube.com/watch?v=VqBjsaKQU60>



Hubble: Galaxies Across Space and Time

<https://www.youtube.com/watch?v=q0P2-qcos90>

GN-Z11 video

<https://www.nasa.gov/feature/goddard/2016/hubble-team-breaks-cosmic-distance-record>

Casimir Effects - Peter Milonni

<https://www.youtube.com/watch?v=12yjbyunRdM>

CLUES - Constrained Local Universe Evolution Simulation

https://www.youtube.com/watch?v=ulfX_47ovPU

NASA's WFIRST Mission

https://www.youtube.com/watch?v=cxmg-X7Dxug&feature=em-subsub_digest

The BaBar Detector

<https://www.youtube.com/watch?v=KusaugMR5IU>

How Does Fusion Power the Sun?

<https://www.youtube.com/watch?v=W1ZQ4JBv3-Y>

Hypnotic Solar Explosions 4K

<https://www.youtube.com/watch?v=lpzCSZ7Eerc>

4K | Universe's Evolution in 8K Fulldome - Illustris Simulation

<https://www.youtube.com/watch?v=C1zXumtY6x0>

Books & Papers

Introduction to Cosmology by Barbara Ryden, 2017

Cosmology and Controversy by Helge Kragh, 1996

Baryogenesis whitepaper

https://www.astro.umd.edu/~ricotti/NEWWEB/teaching/ASTR688s08/bhupal_termpaper.pdf

Paper-and-pencil cosmological calculator

<https://arxiv.org/abs/1303.5961>

Friedmann equations

http://zuserver2.star.ucl.ac.uk/~hiranya/PHAS3136/PHAS3136/PHAS3136_files/Co_smo2_34_fried.pdf



Professor Komissarov S.S.Komissarov@leeds.ac.uk lecture on cosmology with equations.

<https://www1.maths.leeds.ac.uk/~serguei/teaching/cosmology.pdf>

Ohio State course notes

<http://www.astronomy.ohio-state.edu/~dhw/A5682/notes4.pdf>

A Dynamical Study of the Friedmann Equations

<http://cds.cern.ch/record/515592/files/0108066.pdf>

Big-Bang Cosmology

<http://pdg.lbl.gov/2009/reviews/rpp2009-rev-bbang-cosmology.pdf>

Lecture 19 Big Bang Cosmology slides

http://www.pas.rochester.edu/~aran/class/PHY100_10S/lectures/P100_19_BigBang_Cosmology.pdf

Big Bang Cosmology and the Microwave Background

<http://permlink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-94-2608-08>

Big Bang Cosmology slides

<http://www.astro.uwo.ca/~basu/teach/ast020/notes/cosmology.pdf>

Planck spacecraft measures of CMB

[https://en.wikipedia.org/wiki/Planck_\(spacecraft\)#Results](https://en.wikipedia.org/wiki/Planck_(spacecraft)#Results)

How inhomogeneous is it graph?

<https://ned.ipac.caltech.edu/level5/March03/Freedman/Figures/figure11.jpg>

Evidence from Type Ia Supernovae for an Accelerating Universe and Dark Energy

<https://arxiv.org/pdf/astro-ph/0307139.pdf>

Measuring energy density

http://www-f9.ijs.si/~margan/Articles/vacuum_energy_density.pdf

What's the Energy Density of the Vacuum?

http://www.nicadd.niu.edu/~bterzic/PHYS652/Lecture_10.pdf

Statistics of Caustics in Large-Scale Structure Formation

<https://arxiv.org/pdf/1412.5121.pdf>

Improved cosmological constraints from a joint analysis of the SDSS-II and SNLS supernova samples

<https://arxiv.org/pdf/1401.4064.pdf>

Measuring Cosmological Parameters via Expansion

<http://www.astronomy.ohio-state.edu/~dhw/A5682/notes9.pdf>



Nucleosynthesis Predictions and High-Precision Deuterium Measurements

<https://arxiv.org/pdf/1705.03653.pdf>

Measurements of the deuterium abundance in quasar absorption systems

<https://arxiv.org/abs/astro-ph/9803071>

History of CP Violation

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3422684/>

Good PowerPoint on inflation

http://www.phys.unm.edu/~gbtaylor/astr422/lectures/22_A422_EarlyUniverse_I.pdf

Websites

Ned Wright's Cosmology Tutorial with a great FAQ section

<http://www.astro.ucla.edu/~wright/cosmolog.htm>

HyperPhysics

<http://hyperphysics.phy-astr.gsu.edu>

Gamma Ray Bursts

<http://cseligman.com/text/galaxies/lighttravel.htm>

https://www.nasa.gov/mission_pages/swift/bursts/cosmic_record.html

<http://science.psu.edu/news-and-events/2011-news/Fox5-2011>

Cosmology lecture PowerPoint from University College London

http://zuserver2.star.ucl.ac.uk/~hiranya/PHAS3136/PHAS3136/PHAS3136_files/Cosmo2_34_fried.pdf

Wilkinson Microwave Anisotropy Probe

<https://map.gsfc.nasa.gov/>

GTR version of Friedmann Equations

<https://astrobites.org/2011/10/09/general-relativity-friedmann-equations-and-accelerating-expansion-a-quick-overview/>

<http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/fried.html>

The Hubble constant value

<https://www.cfa.harvard.edu/~dfabricant/huchra/hubble/>

Bound and unbound escape velocity

http://staff.on.br/jlkm/astron2e/AT_MEDIA/CH26/CHAP26AT.HTM



University of Oregon lecture

<http://abyss.uoregon.edu/~js/cosmo/lectures/lec05.html>

Energy Density of the Vacuum

<http://math.ucr.edu/home/baez/vacuum.html>

SDSS web layout of the galaxies

<http://ircamera.as.arizona.edu/NatSci102/NatSci102/lectures/galaxydist.htm>

Dark Energy, Dark Matter

<http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy>

Distance vs Redshift

<https://www.eso.org/~bleibund/papers/EPN/ePN.html>

http://hubblesite.org/image/2014/news_release/2006-52

Host Galaxies of Distant Supernovae

<http://supernova.lbl.gov/video.html>

Supernova profile

<http://www2.lbl.gov/Science-Articles/Archive/sabl/2005/October/04-supernovae.html>

Supernovae: The Stellar Route to Understanding Dark Energy

<http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/inflat.html#c1>

Inflationary Period in Big Bang

<https://www.cfa.harvard.edu/news/2011-04>

The Best Way to Measure Dark Energy Just Got Better

<http://math.ucr.edu/home/baez/vacuum.html>

Cosmic Inventory II: Baryonic and Dark Matter

<http://hubblesite.org/video/798/news/91-astronomical>

The Cosmic Microwave Background

<http://planck.cf.ac.uk/science/cmb>

<http://astronomy.swin.edu.au/cosmos/C/Critical+Density>

Critical density calculations.



<http://www.astro.ucla.edu/~wright/density.html>

Abell 370

<http://www.spacetelescope.org/images/heic1711a/>

Estimating the Vacuum Energy Density - an Overview of Possible Scenarios Erik Margan

https://en.wikipedia.org/wiki/Observable_universe#/media/File:Observable_universe_log_arithmic_illustration.png

2MASS Redshift Survey

<https://www.cfa.harvard.edu/~dfabricant/huchra/2mass/>

THE COSMIC MICROWAVE BACKGROUND

<https://ned.ipac.caltech.edu/level5/Sept02/Kinney/Kinney3.html>

High Red Shift Supernovae 1a and Cosmic Acceleration

<http://web.physics.ucsb.edu/~jatila/LambdaLabs/>

Fractal Structure of Isothermal Lines and Loops on the Cosmic Microwave Background

<http://inspirehep.net/record/880036>

Ionization of Hydrogen

http://csep10.phys.utk.edu/OJTA2dev/ojta/c2c/ordinary_stars/harvard/ionization_tl.html

Cosmic Inflation

https://ned.ipac.caltech.edu/level5/Glossary/Essay_1ss.html

Formation of a group of galaxies

<http://cosmicweb.uchicago.edu/group.html>

South America Galaxy

<https://www.spacetelescope.org/images/potw1323a/>

Casimir effect

<https://briankoberlein.com/2015/03/06/nothing-but-net/>

Evolving the Universe, from the Cosmic Microwave Background to now

<https://map.gsfc.nasa.gov/resources/animconcepts.html>

CASIMIR EFFECT LINKS

<http://www.mit.edu/~kardar/research/seminars/Casimir2010/talks/Konstanz/Casimir.html>

iPTF16geu $z = 0.4$ 4.3 bly

<https://www.spacetelescope.org/news/heic1710/>

SN UDS10Wil



https://www.nasa.gov/mission_pages/hubble/science/sn-wilson.html

SN CL012Car $z = 1.28$

<http://www.spacefellowship.com/news/art38400/hubble-astronomers-use-supernovae-to-gauge-power-of-cosmic-lenses.html>

Expansion history graph creator

<http://csep10.phys.utk.edu/guidry/darkEnergy/universeEvolRK.html>

Hot quark soup that existed at the dawn of the universe

<https://www.sciencedaily.com/releases/2015/04/150414125710.htm>

Theory provides roadmap in quest for quark soup 'critical point'

<https://phys.org/news/2017-01-theory-roadmap-quest-quark-soup.html>

BaBar has now discovered *direct* CP violation for B mesons.

<http://www2.slac.stanford.edu/tip/special/cp.htm>

Scientists Search for Quasar's "Missing" Galaxy

<https://scitechdaily.com/scientists-search-for-quasars-missing-galaxy/>

pks 1937-101 (qso B1937-1009)

<http://simbad.u-strasbg.fr/simbad/sim-id?Ident=%20PKS%201937-101%20>

Cosmic Microwave Background

<http://astronomy.swin.edu.au/cosmos/C/Cosmic+Microwave+Background>

CP Violation in Kaon Decay

<http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html>

NASA's WFIRST Mission

https://www.youtube.com/watch?v=cxmg-X7Dxug&feature=em-subsub_digest

Daya Bay Reactor Neutrino Experiment

<https://www.bnl.gov/newsroom/news.php?a=111395>

Hot quark soup that existed at the dawn of the universe

<https://www.sciencedaily.com/releases/2015/04/150414125710.htm>

ALAS hunt for dark matter

<http://atlas.cern/updates/physics-briefing/chasing-invisible>

LISA

<https://lisa.nasa.gov/>



<https://www.youtube.com/watch?v=TsgfnkSJdq5>

Supernovae Cosmology Project

<http://supernova.lbl.gov/>

The High Z SN Search

<https://www.cfa.harvard.edu/supernova/home.html>

ARP 299 4k photo

http://chandra.harvard.edu/photo/4k_images.html