

## TASI Lectures on the Particle Physics and Astrophysics of Dark Matter

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These lecture notes on the particle physics and astrophysics of dark matter (DM) were delivered at TASI 2022 “Ten Years After the Higgs Discovery: Particle Physics Now and Future.” The focus of these lecture notes, aimed at the level of advanced graduate students and beginning postdocs, is on indirect (*i.e.*, astrophysical and cosmological) probes of particle DM models. While DM models and indirect detection are broadly discussed, the examples of weakly interacting massive particles (WIMPs) and axions are worked out in detail. The topics covered include: the role of DM in the cosmology and astrophysics of structure formation, including DM density profiles in galaxies, general constraints on particle DM models, the theory of minimal DM, with the higgsino as a relevant and illustrative example, indirect detection with gamma-rays, including with the upcoming Cherenkov Telescope Array, axions as a solution to the strong- $CP$  problem and a DM candidate, including discussions of possible ultraviolet completions and of axion string cosmology, and astrophysical probes of axions such as with isocurvature perturbations,  $N_{\text{eff}}$ , black hole superradiance, radio telescopes, spectral modulations, stellar polarization, and stellar cooling, amongst other topics. Example Jupyter notebooks are provided that walk the reader through relevant analyses, including an example statistical analysis of a DM annihilation search towards the Segue I dwarf galaxy with gamma-ray data from the *Fermi* Large Area Telescope that is relevant for DM explanations of the *Fermi* Galactic Center Excess. We also provide an introduction to frequentist statistics for particle and astro-particle physics. These lecture notes are meant to be pedagogical, with the focus on explaining the underlying physical principles and analysis techniques that are set to play crucial roles in the search for particle DM in the coming decade.

*TASI 2022 – “Ten Years After the Higgs Discovery: Particle Physics Now and Future,”  
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# Lecture Tutorials For Dark Matter Answer Key

**PT Brinkman**



## Lecture Tutorials For Dark Matter Answer Key:

Relativity, Gravitation and Cosmology Ta-Pei Cheng, 2010 An introduction to Einstein's general theory of relativity this work is structured so that interesting applications such as gravitational lensing black holes and cosmology can be presented without the readers having to first learn the difficult mathematics of tensor calculus

**Physics Briefs**, 1994

**Sound** Bella Bathurst, 2018-10-02 A moving and fascinating book about sound and what it means to be human from the Somerset Maugham Award winning author of *The Lighthouse* *Stevensons* *Financial Times* In this surprising and moving book award winning writer Bella Bathurst shares the extraordinary true story of how she lost her hearing and eventually regained it and what she learned from her twelve years of deafness Diving into a wide ranging exploration of silence and noise she interviews psychologists ear surgeons and professors to uncover fascinating insights about the science of sound But she also speaks with ordinary people who are deaf or have lost their hearing including musicians war veterans and factory workers to offer a perceptive thought provoking look at what sound means to us If sight gives us the world then hearing or our ability to listen gives us our connections with other people But as this smart funny and profoundly honest examination reveals our relationship with sound is both more personal and far more complex than we might expect Bathurst is a restless curious writer After reading this book I found myself listening in a richer and more interested way *The Guardian* A hymn to the faculty of hearing by someone who had it lost it and then found it again written with passion and intelligence terrifying absorbing and ultimately uplifting *Literary Review* Bathurst's affecting memoir will enlighten and educate *Publishers Weekly* A memoir of hearing loss and what the author learned through her unexpected recovery from it A good writer knows material when it presents itself and Bathurst is a very good writer *Kirkus Reviews*

**The Journal of Education**, 1894 *Journal of Education and School World*, 1894

**English Mechanic and Mirror of Science and Art**, 1918 *New York Magazine*, 1991-08-12 *New York Magazine* was born in 1968 after a run as an insert of the *New York Herald Tribune* and quickly made a place for itself as the trusted resource for readers across the country With award winning writing and photography covering everything from politics and food to theater and fashion the magazine's consistent mission has been to reflect back to its audience the energy and excitement of the city itself while celebrating New York as both a place and an idea

**Educational Times**, 1909 *Mathematical Reviews*, 2000 *The Athenaeum*, 1912 *The Educational Times, and Journal of the College of Preceptors*, 1909

**Educational Times and Journal of the College of Preceptors**, 1909

*English Mechanics and the World of Science*, 1919 *Journal of Education*, 1894 *Education Outlook*, 1908 *Catalogue* University of California, Santa Cruz,

**Resources in Education**, 1991-07 *The Engineer*, 1875

*Cognitive and Affective Responses to Advertising* Patricia Cafferata, Alice M. Tybout, 1989 Practitioner's and academicians views are integrated in this overview of current thought regarding consumers cognitive and affective responses to advertising

**Indianapolis Monthly**, 2004-04 *Indianapolis Monthly* is the Circle City's essential chronicle and guide an

indispensable authority on what's new and what's news Through coverage of politics crime dining style business sports and arts and entertainment each issue offers compelling narrative stories and lively urbane coverage of Indy's cultural landscape

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