# Quantum Mechanics_Astrophysics

**Astrophysics** (from Greek *astron*, ἄστρον "star", and*physis*, φύσις "nature") is the branch of astronomy that deals with the physics of the universe, especially with "the nature of the heavenly bodies, rather than their positions or motions in space."[1][2] Among the objects studied are galaxies, stars, planets, extrasolar planets, the interstellar medium and the cosmic microwave background.[3][4] Their emissions are examined across all parts of the electromagnetic spectrum, and the properties examined include luminosity, density,temperature, and chemical composition. Because astrophysics is a very broad subject, *astrophysicists*typically apply many disciplines of physics, includingmechanics, Electromagnetism, Statistical mechanics,Thermodynamics, Quantum mechanics, Relativity,nuclear and Particle physics, and atomic and molecular physics.

In practice, modern astronomical research often involves a substantial amount of work in the realm(s) of theoretical and/or observational physics. Highly elusive areas of study for astrophysicists, which are of immense interest to the public, include their attempts to determine: the properties of dark matter, dark energy, and black holes; whether or not time travel is possible, wormholes can form, or the multiverse exists; and the origin and ultimate fate of the universe.[5]Topics also studied by theoretical astrophysicists include: solar system formation and evolution; stellar dynamics and evolution; galaxy formation and evolution;magnetohydrodynamics; large-scale structure of matter in the universe;

origin ofcosmic rays; general relativity and physical cosmology, including stringcosmology and astroparticle physics.

Astrophysics can be studied at the bachelors, masters, and Ph.D. levels in physics or astronomy departments at many universities. Many such programs[which?]retain the name "astronomy" for historical purposes[why?].

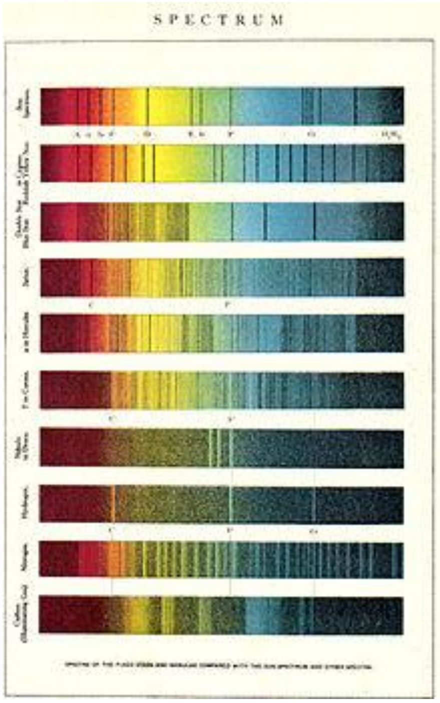
## History

Although astronomy is as ancient as recorded history itself, it was long separated from the study of terrestrial physics. In the Aristotelian worldview, bodies in the sky appeared to be unchanging spheres whose only motion was uniform motion in a circle, while the earthly world was the realm which underwent growth and decay and in which natural motion was in a straight line and ended when the moving object reached its goal. Consequently, it was held that the celestial region was made of a fundamentally different kind of matter from that found in the terrestrial sphere; either Fire as maintained by Plato, or Aether as maintained byAristotle.[6][7]

In the 17th century, natural philosophers such as Galileo, Descartes, and Newtonbegan to maintain that the celestial and terrestrial regions were made of similar kinds of material and were subject to the same natural laws.

At the end of the 19th century, it was discovered that, when decomposing the light from the Sun, a multitude of spectral lines were observed (regions where there was less or no light). Laboratory experiments with hot gases showed that the same lines could be observed in the spectra of known gases, specific lines corresponding to unique chemical elements. In this way it was proved that the chemical elements found in the Sun and stars (chiefly hydrogen) were also found on Earth. Indeed, the element helium was first discovered in the spectrum of the Sun and only later found on Earth, hence its name. During the 20th century,spectroscopy (the study of these spectral lines) advanced, particularly as a result of the advent of quantum physics that was necessary to understand theastronomical and experimental observations.[8]

## Observational astrophysics




Early 20th-century comparison of elemental, solar, and stellar spectra

Observational astronomy is a division of the astronomical science that is concerned with recording data, in contrast with theoretical astrophysics, which is mainly concerned with finding out the measurable implications of physicalmodels. It is the practice of observing celestial objects by using telescopes and other astronomical apparatus .

The majority of astrophysical observations are made using the electromagnetic spectrum.

- Radio astronomy studies radiation with a wavelength greater than a few millimeters. Example areas of study are radio waves, usually emitted by cold objects such as interstellar gas and dust clouds; the cosmic microwave background radiation which is the redshifted light from the Big Bang; pulsars, which were first detected at microwave frequencies. The study of these waves requires very large radio telescopes.
- Infrared astronomy studies radiation with a wavelength that is too long to be visible to the naked eye but is shorter than radio waves. Infrared observations are usually made with telescopes similar to the familiar optical telescopes. Objects colder than stars (such as planets) are normally studied at infrared frequencies.

- Optical astronomy is the oldest kind of astronomy. Telescopes paired with acharge-coupled device or spectroscopes are the most common instruments used. The Earth's atmosphere interferes somewhat with optical observations, soadaptive optics and space telescopes are used to obtain the highest possible image quality. In this wavelength range, stars are highly visible, and many chemical spectra can be observed to study the chemical composition of stars, galaxies and nebulae.
- Ultraviolet, X-ray and gamma ray astronomy study very energetic processes such as binary pulsars, black holes, magnetars, and many others. These kinds of radiation do not penetrate the Earth's atmosphere well. There are two methods in use to observe this part of the electromagnetic spectrum—space-based telescopes and ground-based imaging air Cherenkov telescopes (IACT). Examples of Observatories of the first type are RXTE, the Chandra X-ray Observatory and the Compton Gamma Ray Observatory. Examples of IACTs are the High Energy Stereoscopic System (H.E.S.S.) and the MAGIC telescope.

Other than electromagnetic radiation, few things may be observed from the Earth that originate from great distances. A few gravitational wave observatories have been constructed, but gravitational waves are extremely difficult to detect.Neutrino observatories have also been built, primarily to study our Sun. Cosmic rays consisting of very high energy particles can be observed hitting the Earth's atmosphere.

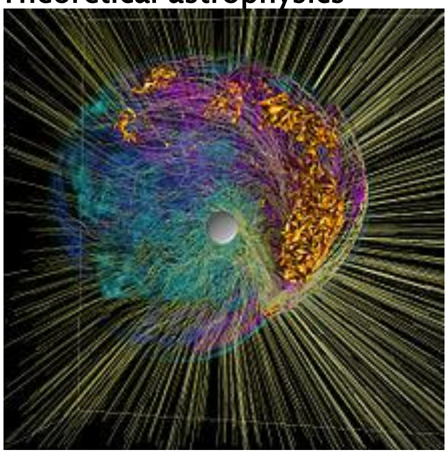
Observations can also vary in their time scale. Most optical observations take minutes to hours, so phenomena that change faster than this cannot readily be observed. However, historical data on some objects is available, spanningcenturies or millennia. On the other hand, radio observations may look at events on a millisecond timescale (millisecond pulsars) or combine years of data (pulsar deceleration studies). The information obtained from these different timescales is very different.

The study of our very own Sun has a special place in observational astrophysics. Due to the tremendous distance of all other stars, the Sun can be observed in a kind of detail unparalleled by any other star. Our understanding of our own sun serves as a guide to our understanding of other stars.

The topic of how stars change, or stellar evolution, is often modeled by placing the varieties of star types in their respective positions on the Hertzsprung-Russell diagram, which can be viewed as representing the state of a stellar object, from birth to destruction. The material composition of the astronomical objects can often be examined using:

- spectroscopy
- Radio astronomy
- Neutrino astronomy (future prospects)

**Theoretical astrophysics**



The stream lines on this simulation of asupernova show the flow of matter behind the shock wave giving clues as to the origin of pulsars

Theoretical astrophysicists use a wide variety of tools which include analytical models (for example, polytropes to approximate the behaviors of a star) andcomputational numerical simulations. Each has some advantages. Analytical models of a process are generally better for giving insight into the heart of what is going on. Numerical models can reveal the existence of phenomena and effects that would otherwise not be seen.[9][10]

Theorists in astrophysics endeavor to create theoretical models and figure out the observational consequences of those models. This helps allow observers to look for data that can refute a model or help in choosing between several alternate or conflicting models.

Theorists also try to generate or modify models to take into account new data. In the case of an inconsistency, the general tendency is to try to make minimal modifications to the model to fit the data. In some cases, a large amount of inconsistent data over time may lead to total abandonment of a model.

Topics studied by theoretical astrophysicists include: stellar dynamics and evolution; galaxy formation and evolution; magnetohydrodynamics; large-scale structure of matter in the universe; origin of cosmic rays; general relativity and physical cosmology, including string cosmology and astroparticle physics. Astrophysical relativity serves as a tool to gauge the properties of large scale structures for which gravitation plays a significant role in physical phenomena investigated and as the basis for black hole (*astro*)physics and the study ofgravitational waves.

Some widely accepted and studied theories and models in astrophysics, now included in the Lambda-CDM model are the Big Bang, Cosmic inflation, dark matter, dark energy and fundamental theories of physics. wormholes are examples of hypotheses which are yet to be proven (or disproven).

## References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