

FÍSICA PARA ARCA
cómo funciona el mundo:

PRESENTACIÓN DEL CURSO DE FÍSICA

ASTROFÍSICA Y COSMOLOGÍA

ASTROPHYSICS DISCOVER HOW THE UNIVERSE WORKS, EXPLORE HOW IT BEGAN AND EVOLVED, AND SEARCH FOR LIFE ON PLANETS AROUND OTHER STARS.

COSMOLOGY IS THE SCIENTIFIC STUDY OF THE LARGE SCALE PROPERTIES OF THE UNIVERSE AS A WHOLE. IT ENDEAVORS TO USE THE SCIENTIFIC METHOD TO UNDERSTAND THE ORIGIN, EVOLUTION AND ULTIMATE FATE OF THE ENTIRE UNIVERSE

Masterclass de Física



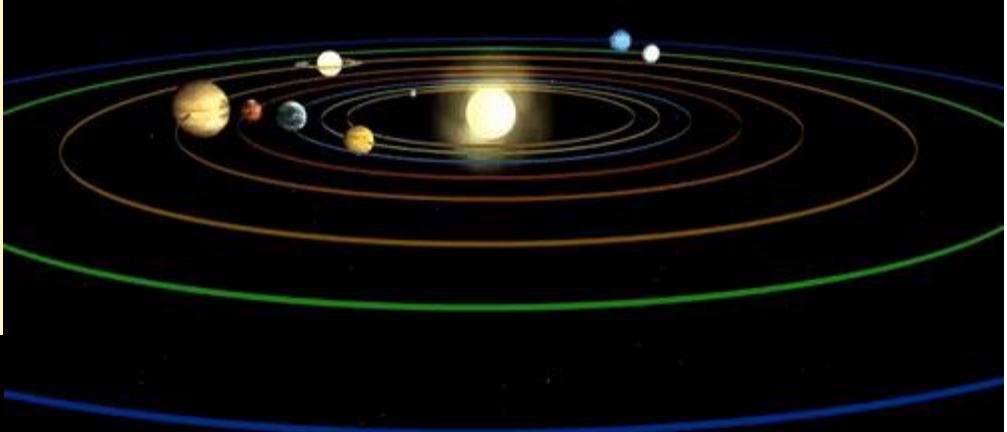
Martes 14 de febrero,
18:00 horas

Os invitamos a participar en la Masterclass **on line** en la que se tratarán estos temas:

- ASTROFÍSICA: EL UNIVERSO**
- FÍSICA CUÁNTICA: EL ÁTOMO**
- LA BASE DE NUESTRA VIDA: LA TIERRA Y EL SOL**
- LAS REVOLUCIONES INDUSTRIALES(1800,1900,2000,HOY)**
- LA ECOLOGÍA Y EL PROGRESO**

Impartida por el ingeniero de Armas Navales, Basilio Martí Mingarro.

The SOLAR SYSTEM is the gravitationally bound system of the Sun and the objects that orbit it. It formed 4.6 BILLION YEARS AGO from the gravitational collapse of a giant interstellar molecular cloud. The vast majority (99.86%) of the system's mass is in the Sun, with most of the remaining mass contained in the planet Jupiter. The four inner system planets—Mercury, Venus, Earth and Mars—are terrestrial planets, being composed primarily of rock and metal. The four giant planets of the outer system are substantially larger and more massive than the terrestrials. The two largest, Jupiter and Saturn, are gas giants, being composed mainly of hydrogen and helium; the next two, Uranus and Neptune, are ice giants, being composed mostly of volatile substances with relatively high melting points compared with hydrogen and helium, such as water, ammonia, and methane. All eight planets have nearly circular orbits that lie near the plane of Earth's orbit, called the ecliptic.

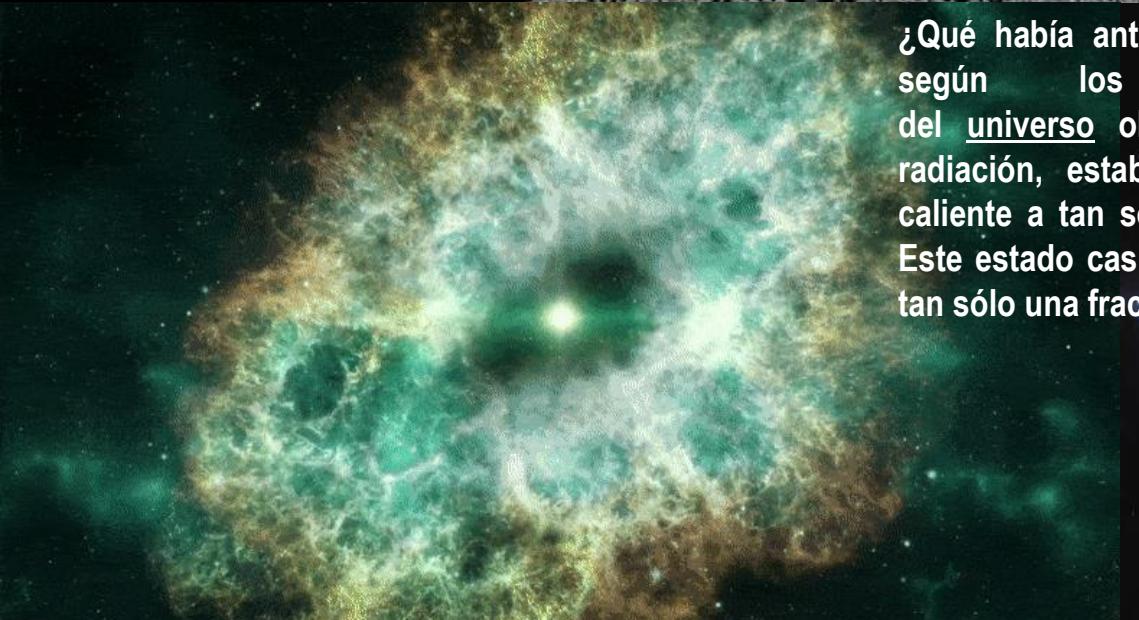


LA TIERRA: 4,543 miles de millones años

SISTEMA SOLAR Y PLANETAS

13,700 millones de años

¿Qué había antes del Big Bang? Antes del Big Bang, según los científicos, la inmensidad del universo observable, incluida toda su materia y radiación, estaba comprimida en una masa densa y caliente a tan solo unos pocos milímetros de distancia. Este estado casi incomprendible se especula que existió tan sólo una fracción del primer segundo de tiempo.



La teoría más conocida sobre el origen del universo se centra en un cataclismo cósmico sin igual en la historia: el Big Bang. Esta teoría surgió de la observación del alejamiento a gran velocidad de otras galaxias respecto a la nuestra en todas direcciones, como si hubieran sido repelidas por una antigua fuerza explosiva. Con el exitoso lanzamiento y despliegue del telescopio espacial James Webb la comunidad científica pretenden obtener más datos sobre el origen del universo.

Layers from Crust to Core

Lithosphere

Layer	Depth	Temperature
Rocky Crust	0 km	0°C
Upper Mantle	40	870°C
Mantle	150	
	400	
	650	
Inner Mantle	2,700	
Semi-rigid	2,890	
Molten Outer Core	3,700°C	
Iron/nickel		
Inner Core	5,150	
Iron/nickel		
	6,378	
		4,300°C
		7,200°C

SURFACE AND CRUST: The Earth's surface is composed mostly of water, basalt and granite. Oceans cover about 70% of Earth's surface. These oceans are up to 3 to 7 km deep.

Crust
Continental crust (granitic)
Oceanic crust (basaltic)

The Earth's thin, ROCKY CRUST is composed of SILICON, ALUMINUM, CALCIUM, SODIUM AND POTASSIUM. The crust is divided into continental plates which drift slowly (only a few centimeters each year) atop the less rigid mantle.

Gutenberg Discontinuity

The crust is thinner under the oceans (6-11 km thick); this is where new crust is formed. Continental crust is about 25-90 km thick.

The lithosphere is defined as the crust and the upper mantle, a rigid layer about 100-200 km thick. The Mohorovicic discontinuity is the separation between the crust and the upper mantle.



CAPAS DE LA CORTEZA AL NÚCLEO

EDAD DE LA TIERRA: 4,543 miles de millones años

El núcleo de la Tierra es su esfera central, la más interna de las que constituyen la [estructura de la Tierra](#). Está compuesto fundamentalmente por [hierro](#), con 5-10 % de [níquel](#) y menores cantidades de [elementos](#) más ligeros, tal vez [azufre](#) y [oxígeno](#). Tiene un [radio](#) de cerca de 3500 [km](#), mayor que el [planeta Marte](#) y representa el 32 % de la masa total de la Tierra. La presión en su interior es millones de veces la presión en la superficie y la temperatura puede superar los 6700 [°C](#). Consta de un [núcleo externo](#) líquido y un [núcleo interno](#) sólido. Anteriormente era conocido con el nombre de [NiFe](#) debido a su riqueza en [níquel](#) y [hierro](#)

El núcleo interno de la Tierra puede ser rico en oxígeno. El oxígeno puede existir en el núcleo interno sólido de la Tierra, según un estudio que aporta restricciones clave para la comprensión del proceso de formación y evolución del centro planetario. El oxígeno es la sustancia clave para la vida y uno de los elementos más abundantes en la Tierra. Sin embargo, en la investigación previa se desconocía si el oxígeno está presente en el núcleo interno, que está compuesto de hierro casi puro.. Debido a que el núcleo interno está mucho más allá del alcance de los humanos, solo podemos inferir su densidad y composición química a partir de las [señales sísmicas](#) generadas por los terremotos. En la actualidad, se cree que existen elementos ligeros en el núcleo interno, pero el tipo y el contenido aún se debaten. La evidencia cosmoquímica y geoquímica sugiere que debería contener AZUFRE, SILICIO, CARBONO e HIDRÓGENO. ¿Es el núcleo interno de la Tierra tan "anóxico"? Para responder a esta pregunta, en este estudio se llevaron a cabo una serie de experimentos y cálculos teóricos. Para estar cerca de la temperatura y la presión del núcleo de la Tierra, se colocaron hierro puro y óxido de hierro en las puntas de dos yunque de diamante y se calentaron con un rayo láser de alta energía. Después de muchos intentos, se descubrió que se produce una reacción química entre el hierro y el óxido de hierro

That there is no radioactivity in the earth's core is a concept that has long been held. The reason is that the major radioactive elements, potassium and uranium, exist as siderophobic compounds, such as silicates and oxides, in the earth's mantle and thus were thought to be immiscible with the metal core. An experimental measurement of the binary system of steel and UO₂, however, shows that above 3120 K the system is a two-phase liquid, the one rich in UO₂ and the other poor in UO₂. The phase diagram predicts that there must be a temperature above which there is total miscibility between UO₂ and steel. This temperature may be above the boiling point of UO₂, estimated as 3750 K. The temperature at the core-mantle interface of the earth's interior is estimated most recently as 3130 K. Thus there is a strong likelihood that uranium exists in the earth's metal core. Hence the natural alpha radioactivity of uranium offers a power source for the earth's magnetic dynamo.

Radioactive POTASSIUM, URANIUM AND THORIUM are thought to be the three main sources of heat in the Earth's interior, aside from that generated by the formation of the planet.

For all this, however, Marone says, the vast majority of the heat in Earth's interior—up to 90 percent—is fueled by the decaying of radioactive isotopes like Potassium 40, Uranium 238, 235, and Thorium 232 contained within the mantle. These isotopes radiate heat as they shed excess energy and move toward stability.



CALOR DE LA TIERRA

La Tierra está formada por un núcleo, dividido en interno y externo, el manto y la corteza. Se sabe que el núcleo interno es una esfera de hierro y níquel con un radio de 1.221 kilómetros. Su temperatura de 5.400°C es casi tan alta como la del Sol (5.700°C). Pero está a una profundidad tal que se mantiene como una esfera sólida de metal. Investigaciones anteriores han demostrado que el núcleo está separado del resto de la Tierra por una capa externa de metal líquido, o núcleo externo. Esto significa que el interno puede girar de forma independiente y no necesariamente de forma sincronizada con el resto del planeta. Pero comprender cómo rota exactamente ha sido objeto de debate entre científicos durante décadas. LOS CAMBIOS EN EL NÚCLEO Al observar ondas sísmicas causadas por terremotos, los científicos tienen una mejor idea de lo que está sucediendo en el centro del planeta sin la necesidad de hacer perforaciones. Los grandes terremotos ocurren en regiones de la corteza de la Tierra y envían energía a través del planeta, la cual puede rebotar hacia la superficie.

El núcleo es la capa más profunda de la Tierra y se divide en dos partes. La más externa está a entre 2.900 y 5.100 kilómetros de la superficie y está compuesta en su mayor parte por hierro fundido, es decir, líquido. La más interna (como si fuera el hueso de un melocotón) es una esfera situada justo en el centro del planeta, con unos 1.200 kilómetros de radio, y es de hierro sólido. Por eso, ese núcleo interno gira a su propio ritmo, de forma independiente del resto del planeta. ¿Cómo sabemos todo esto si apenas hemos podido perforar unos kilómetros en la superficie? Gracias al estudio de la propagación de las ondas sísmicas desde hace casi un siglo.



WHY IS THE EARTH'S CORE SO HOT? AND HOW DO SCIENTISTS MEASURE ITS TEMPERATURE?

Quentin Williams, associate professor of earth sciences at the University of California at Santa Cruz offers this explanation

There are three main sources of heat in the deep earth: (1) heat from when the planet formed and accreted, which has not yet been lost; (2) frictional heating, caused by denser core material sinking to the center of the planet; and (3) heat from the decay of **RADIOACTIVE ELEMENTS**. It takes a rather long time for heat to move out of the earth. This occurs through both "convective" transport of heat within the earth's liquid outer core and solid mantle and slower "conductive" transport of heat through nonconvecting boundary layers, such as the earth's plates at the surface. As a result, much of the planet's primordial heat, from when the earth first accreted and developed its core, has been retained.

The amount of heat that can arise through simple accretionary processes, bringing small bodies together to form the proto-earth, is large: on the order of 10,000 kelvins (about 18,000 degrees Farhenheit). The crucial issue is how much of that energy was deposited into the growing earth and how much was reradiated into space. Indeed, the currently accepted idea for how the moon was formed involves the impact or accretion of a Mars-size object with or by the proto-earth. When two objects of this size collide, large amounts of heat are generated, of which quite a lot is retained. This single episode could have largely melted the outermost several thousand kilometers of the planet.

We derive our primary estimate of the temperature of the deep earth from the melting behavior of iron at ultrahigh pressures. We know that the earth's core depths from 2,886 kilometers to the center at 6,371 kilometers (1,794 to 3,960 miles), is predominantly iron, with some contaminants. How?

The speed of sound through the core (as measured from the velocity at which seismic waves travel across it) and the density of the core are quite similar to those seen in iron at high pressures and temperatures, as measured in the laboratory. Iron is the only element that closely matches the seismic properties of the earth's core and is also sufficiently abundant present in sufficient abundance in the universe to make up the approximately 35 percent of the mass of the planet present in the core.

Additionally, descent of the dense iron-rich material that makes up the core of the planet to the center would produce heating on the order of 2,000 kelvins (about 3,000 degrees F). The magnitude of the third main source of heat--radioactive heating--is uncertain. The precise abundances of radioactive elements (primarily potassium, uranium and thorium) are poorly known in the deep earth. In sum, there was no shortage of heat in the early earth, and the planet's inability to cool off quickly results in the continued high temperatures of the Earth's interior. In effect, not only do the earth's plates act as a blanket on the interior, but not even convective heat transport in the solid mantle provides a particularly efficient mechanism for heat loss. The planet does lose some heat through the processes that drive plate tectonics, especially at mid-ocean ridges. For comparison, smaller bodies such as Mars and the Moon show little evidence for recent tectonic activity or volcanism.

The earth's core is divided into two separate regions: the liquid outer core and the solid inner core, with the transition between the two lying at a depth of 5,156 kilometers (3,204 miles). Therefore, If we can measure the melting temperature of iron at the extreme pressure of the boundary between the inner and outer cores, then this lab temperature should reasonably closely approximate the real temperature at this liquid-solid interface. Scientists in mineral physics laboratories use lasers and high-pressure devices called diamond-anvil cells to re-create these hellish pressures and temperatures as closely as possible. Those experiments provide a stiff challenge, but our estimates for the melting temperature of iron at these conditions range from about 4,500 to 7,500 kelvins (about 7,600 to 13,000 degrees F). As the outer core is fluid and presumably convecting (and with an additional correction for the presence of impurities in the outer core), we can extrapolate this range of temperatures to a temperature at the base of Earth's mantle (the top of the outer core) of roughly 3,500 to 5,500 kelvins (5,800 to 9,400 degrees F) at the base of the earth's mantle.

How do we know the temperature? The answer is that we really don't--at least not with great certainty or precision. The center of the earth lies 6,400 kilometers (4,000 miles) beneath our feet, but the deepest that it has ever been possible to drill to make direct measurements of temperature (or other physical quantities) is just about 10 kilometers (six miles).