SPACE awareness

WHO IS A PLASMA PHYSICIST?

Field Plasma physics, engineering, space sciences
Type Research, industry
Level of study Masters, PhD

What is the field about?

Plasmas are a state of matter that occurs predominantly in space. It is therefore not surprising to see plasma physicists working in all the major domains of space science and technology. For example, the design of a planetary exploration spacecraft requires a detailed understanding of the physics of atmospheric entry plasmas, which are created when a spacecraft travelling at several kilometers per second intersects the atmospheric boundary of a planet or moon (such as Earth, Mars, Venus, Titan, etc...). In this hypersonic flow regime, a strong shockwave is formed, heating the gas surrounding the spacecraft to thousands of degrees, ultimately ionizing it and forming a so-called entry plasma (a phenomena also naturally occurring in Nature in the case of the so-called "shooting stars"). This hot plasma transfers part of its energy to the surface of the spacecraft, thus appropriate thermal protections have to be designed to ensure the structural integrity of the spacecraft.
The mission of an entry plasmas physicist is to reproduce such entry plasmas - either in the laboratory or through computer simulations - and to better understand their underlying physics. This knowledge is then put to use by spacecraft design engineers who are then capable of producing safer, reliable and optimized spacecraft designs.

What would I do every day?

Plasma physicists can either be experimental or computational physicists (sometimes both!).

Experimentalists will, amongst other things, study the effects of the plasma on the spacecraft thermal protections. For this, they can use large plasma wind-tunnels, where there is plasma heated to several thousand degrees in order to test the real conditions that the spacecraft goes through during entry. They can also operate large shock-tubes, which are 20m long facilities that produce shockwaves travelling at extreme velocities of more than 10km/s. The experimentalist will then deploy several state-of-the-art diagnostics to probe and understand the properties of the plasma.

Computational physicists will develop complex computational models to simulate the conditions of hypersonic plasma flows. These simulations are so complex that they require clusters of supercomputers to be run. At the outset of this work, computational physicists interact with design engineers to provide feedback on the design of planetary exploration spacecraft shapes and thermal protections.

How much and what do I need to study?

You are expected to study for the rest of your life! If you enjoy studying, discovering and understanding new physics, this is the right job for you. You should start by obtaining either a master’s degree in physics or aerospace engineering, followed by a doctoral degree (Ph.D).

Where can I work?

Plasma physicists are researchers and will mainly work in research institutions or universities and will follow typical career tracks in academia. Since plasma physics is a broad scientific topic, a successful researcher in the field is expected to also pursue other non-space related interests (like for example plasma chemistry, materials processing, etc...). It is also possible to work in the private sector, chiefly in large space integrator companies, or even in consulting companies providing support to the staff from the European Space Agency. You should expect to work

abroad for extended periods of time or even permanently, since the research community on atmospheric entry plasmas is relatively small and scattered over several large Universities and research institutes over Europe.

This is the job for me, if...

...you always dreamed about space exploration and helping mankind to explore and colonize new planets.

A plasma physicist should be:

Curious and multidisciplinary: The physics of shock-induced, low-pressure, warm atmospheric entry plasmas is still poorly understood since many physical-chemical processes take place during the very small time period (a few milliseconds) the plasma relaxes to equilibrium. Mastering such diverse disciplines such as aerodynamics, thermodynamics, quantum physics and chemistry, spectroscopy and fast acquisition diagnostics, is of paramount importance for achieving a complete understanding of the properties for such space plasmas.

A Citizen of the World: Space exploration is still in its infancy. As such, the amount of planned exploration missions by the different agencies around the world only allows maintaining a relatively small, though highly motivated, scientific team for supporting the space engineers in designing planetary exploration spacecraft. For Europe in particular, different research laboratories and facilities specialize themselves in specific topics of atmospheric entry plasma physics, and at the same time engage in dialogue with other complementary facilities and research groups. Last but not least, worldwide collaborations between teams of the major spacefaring countries (such as Europe, USA, Russia, Japan, India and China) are also customary. A plasma physicist will find himself more often than not travelling all over Europe and the world to meet other researchers, present their findings in international conferences, or participating in test campaigns in partner laboratories.

***The text is kindly provided by Dr. Mario Lino da Silva**, Assistant Researcher on Plasma Physics at Instituto Superior Técnico in Lisbon.*

***Image:** The streak of an ionized plasma plume created by the Atlantis space shuttle's descent through the atmosphere*
***Credit:** NASA/JSC*
***Instrument(s):** ISS - Digital Camera*

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