

Muography: imaging large objects using cosmic particles

Dezső Varga¹

¹High Energy Physics Department, HUN-REN Wigner Research Centre for Physics, Hungary

Naturally occurring cosmic particles, mostly muons, reach the Earth surface continuously and nearly uniformly, and due to their high energy can cross as much as 10-1000m of rock. Since muons propagate along straight lines, one can use these particles for imaging the internal density structure of large objects. More than five decades ago, this method has been used to search for hidden chambers in a pyramid, and subsequently to study various challenging structures: mines, caves, volcanoes, nuclear reactors. Since the turn of the last century, there has been a rapid increase of interest towards muon imaging – with a new research field, called “Muography” emerging – and the application possibilities broadened along with drastic reduction of instrumentation cost, at improved detection efficiency, portability and imaging resolution. The talk will introduce the basic physics behind muography, present the possible detection methods, and give an overview how muographic measurements can take place. Muons can either be absorbed, or scattered (slight deviation from a straight line), and both effects can be used for imaging purposes. The most relevant application possibilities include mining, archeology, volcanology, nuclear industry and border control. Recent investigations revealed voids inside the Great Pyramid of Giza, which remained hidden for millennia. Measurements related to volcanology span three continents, and revealed magma movement, erosion effects and hydrothermal activity, as well as internal (static) structures. Mining applications allow cost reduction (less drilling) and improved operational safety, thus contributing to a sustainable future. Muography allows one to check for high atomic number materials in a short time in large volumes, which is particularly useful for border control and nuclear waste verification. Muography is not only becoming a consistent research field, but there is an international community which facilitates information exchange, critical assessment of the quality of new results, and promotes technology transfer towards an increasing number of industrial partners.