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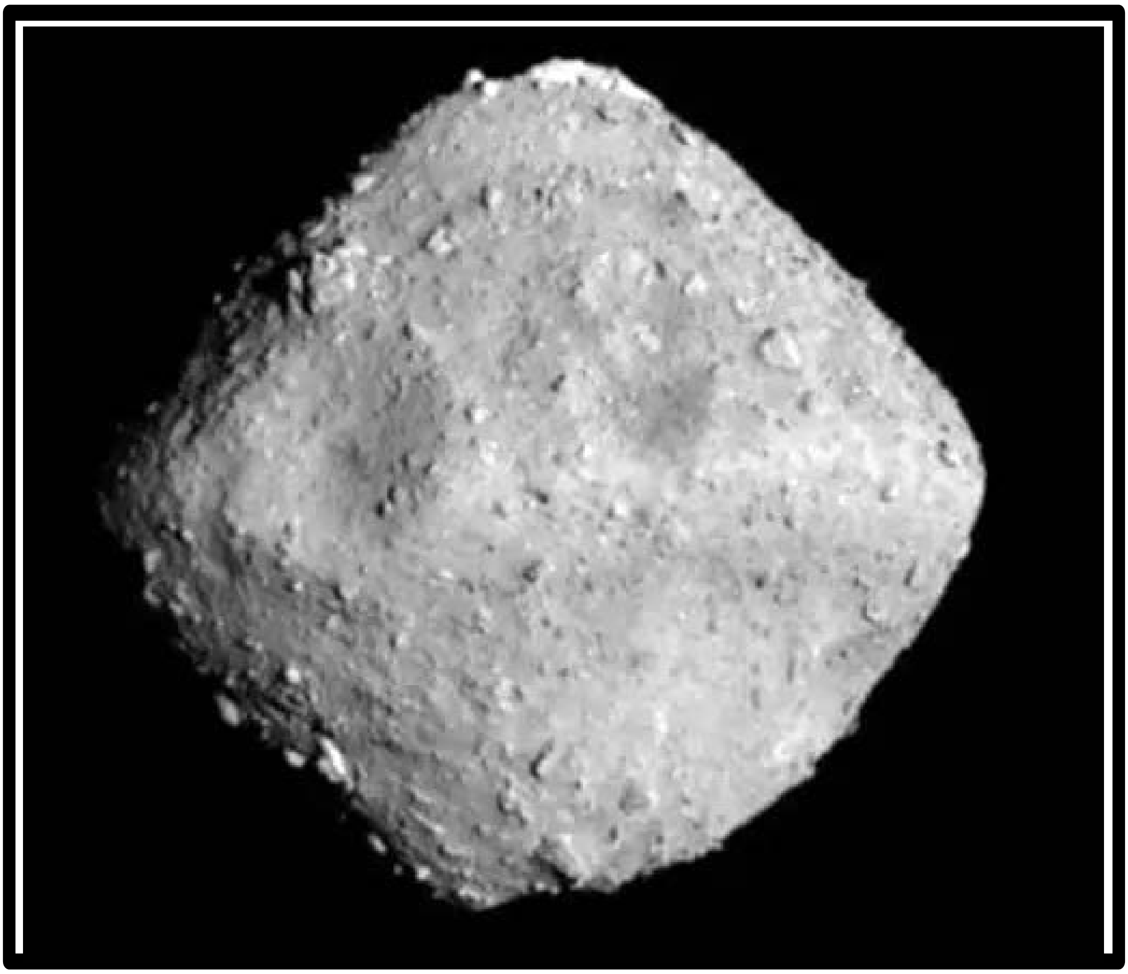
IRPS Bulletin

Newsletter of the International Radiation Physics Society



Photograph of Asteroid Juno taken 20km from the asteroid:870m wide

Ancient asteroid provides insight into the solution of our Solar System

Takagi Niguchi *et al* Nature Astronomy 19 December 2022 DOI: 10.1058

Photograph: ***Hayabasho 2/JAXA:*** ***Taken****: 26 June 2018*

Current IRPS Council Members 2021-2024

Contents of this Journal

From the Editorial Team

Time indeed flies and we have now passed the first quarter of 2023 now, and this is the Vol 1 of the IRPS Bulletin in 2023. We have, sadly, to report that a highly valued member of our Society, José Rodinas Diago (Pepe) has died. An obituary is to be found later in this Bulletin. As well, we have to report that Marcelo Rubio has resigned.

Marcelo served as the Vice-President for South America on the IRPS Council for more than 20 years. Amongst his many contributions to IRPS activities is his involvement as organizer of ISRP-14, which was held in Cordoba, Argentina, in 2018. We thank him for his service to IRPS, and wish him health and happiness in his retirement.

Isabel's President Report is found on page 3. We hope there will be many future articles from her and her associates. Indeed, we hope that many members will take up the challenge and write articles for future editions of the Bulletin.

The announcements for coming conferences conducted under the IRPS auspices are presented on page 6.

Dudley Creagh has provided items for the *Physics from around the World* section. Dudley is hopeful that there are scientists out there who read about important advances in science and who are willing to communicate these advances with others in our society. The reportage is intended to be informal and informative: **not** a magnum opus. One of the principals aims of our society is the cross-communication of information between disciplines/research fields.

This Edition of the Bulletin has been made with the support of Dudley Creagh and Shirley McKeown. Shirley has provided the IRPS Bulletin with assistance in its production, and I, and my predecessors, are grateful to her for her enthusiastic support for the past 30 years

Ming Tsuey Chew

Asteroid Ryugu

COVER PAGE CAPTION

Can be found on page 5

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From the President

Dear Colleagues

Coming back to in-person conferences: towards Bologna and Valencia

In 2023, IRPS conferences are returning, and this is excellent news. We will have two meetings: the 11th International Conference on Industrial Radiation and Radioisotope Measurement Applications (IRRMA2023) which will take place in Bologna, Italy, from July 23rd to 28th (https://irrma.ing.unibo.it/), and the 4th International Conference on Dosimetry and its Applications (ICDA-4) in Valencia, Spain, which will occur in Valencia, Spain, between October 16th and 20th (https://icda-4.webs.upv.es/).

After three very long years, we are finally starting to see the return of *in-person* events. No doubt that digital platforms, like zoom, have helped us immensely overcoming the isolation imposed by the pandemic. Even in normal times, they facilitate some aspects of daily life and scientific work, allowing and promoting meetings that otherwise would not be possible. But when it comes to conferences and other similar scientific meetings, face-to face events are irreplaceable. They have a liveliness and dynamics that remote events lack. Face-to-face meetings offer a unique set of opportunities and allow a wider exchange of ideas.

IRPS conferences are very lively, wide and comprehensive in scientific range. They have been huge successes in bringing radiation physics community together, with a large participation of students and young researchers.

Both IRRMA and ICDA have roughly the same outline. They offer a set of invited topical talks given by leading experts in their fields, as well as plenty of opportunity to contributed talks in which you can present your last results. Furthermore, special attention is given to the presentation of posters. Although both cover topics of radiation physics and their applications, IRRMA and ICDA each have a different focus: while ICDA is centered on the multiple and diverse aspects of the fundamental field of dosimetry, IRRMA covers a wide range of radiation and radioisotope measurement applications in fields as diverse as Biomedicine, Art and Cultural Heritage, Environmental Sciences, Detection of Threat Material and Contraband, Material Science, Radiation Detection and Measurements and others. Furthermore, associated with IRRMA, there will be a satellite workshop of the International Initiative on Fundamental Parameters, with a focus on fundamental aspects and applications of X-ray Spectrometry. This diversity and topicality is a hallmark of our Society and one of its assets.

Last but not least, both Bologna and Valencia are very charming cities, rich in history and cultural attractions, where it is a delight to stroll.

So, you cannot miss them. Plan well in advance as early rates are more favourable. There are also special rates for the IRPS members. If you are not a member yet, you can join IRPS very easily following the instructions available on

https://radiationphysics.org/registrationirps.html

See you in Bologna or Valencia (or both!)

Isabel Lopes

Obituary

José Ródenas Diago

José Ródenas Diago, Professor Emeritus of the Department of Chemical and Nuclear Engineering of the Polytechnic University of Valencia, was an excellent representative of the university for more than 50 years. His career started in 1975, and during his career he taught courses in different areas of Nuclear Engineering, like Nuclear Technology, Nuclear Chemical Technology, Radioactive Protection, Radioisotopes, Radioactive Contamination, Materials and Fuel Cycle, Environmental Problems of Nuclear Energy, Radiation Dosimetry, among others.

José was involved in the delivery of many conferences and courses in a number of Intensive Programs funded by the European Union: Practical Approach to Nuclear Techniques, PAN (2002-2004); Stimulation of Practical Expertise in RAdiatioN Safety, SPERANSA (2006-2008); Intensive Course on Accelerator and Reactor Operation and applications, ICARO (2009-2011); Jülich Nuclear Chemistry Summer School, JUNCSS (2007-2011) y Safe Application of Radiation and radionuclides, SARA (2012-2014).

He wrote two textbooks: Environmental Problems of Nuclear Energy (1994, in Spanish) and Introduction to Engineering of Radioactive Contamination (2003, in Spanish).

In 2005 he created, together to other five European universities, the CHERNE Network (Cooperation for Higher Education on Radiological and Nuclear Engineering). This network comprises more than 20 members, and has the aim of promoting the cooperation by organizing courses to complete the formation of the students of the CHERNE institutions.

Recently, he was Principal Researcher of the project, Train Future Trainers In Radiation Protection And Nuclear Technology, and participated in the project EU Best Practices-Based Education In Radiation Protection and Nuclear Safety Culture For The Belarusian Academia: both devoted to the formation of qualified personnel in Nuclear Security and Radiological Protection in Belorussia.

He was vice director of the Nuclear and Chemical Engineering Department and Liaison Officer with the Nuclear Energy Agency (OECD) Data Bank for more than 40 years.

José was a member of the following societies: Spanish Society of Radiological Protection, Spanish Nuclear Society, and International Radiation Physics Society (IRPS) where he was Vice President for Western Europe 2012-2021.

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Recently he was named consultant of the Australian Research Council (ARC).

In 2014 he organized in Valencia the 9ª edition of the International Topical Meeting on Industrial Radiation and Radioisotope Measurement Applications (IRRMA), chairing the OC and the Technical Committee.

He was Guest Editor of international journals like Radiation Physics and Chemistry, Nuclear Technology and Radiation Protection and Applied Radiation and Isotopes.

His strong interest in teaching led him to the supervision of many PhD students, who profited both from his wisdom and his infectious good humour. José was author of more than 80 scientific articles in prestigious journals and delivered more than 200 presentations in congresses.

At the Polytechnic University of Valencia, he developed an intense activity of knowledge transfer towards Spanish and international companies and institutions obtaining numerous contracts and R&D projects.

The photograph above says it all. José was a friendly, ebullient person. He was full of fun and passion, and a lover of the arts as well as science. His colleagues will miss him and will remember him with love.

Writen by Jorge Fernandez

Asteroid Ryugu *(Cover page)*

The Japanese Astronomical Exploration Agency (JAXA) launched its Hayabusa2 spacecraft in December 2014 to collect samples from Ryugu. After arriving at the asteroid in June 2018, Hayabusa2 deployed two rovers and a small lander on the surface. Then, on Feb. 22, 2019, Hayabusa2 fired an impactor into the asteroid to create an artificial crater. This allowed the spacecraft to remove samples from beneath Ryugu's surface. About 5.4 grams of material were retrieved. The capsule was released from the spacecraft as it passed the Earth was ejected, and was parachuted to Earth landing near the Woomera Range Complex in the South Australia.

https://global.jaxa.jp/press/2020/12/20201206-1_e.html

After initial cataloguing (Phase-1 curation) at the facility established at JAXA's Institute of Space and Astronautical Science, part of the returned sample was distributed to the Hayabusa2 Initial Analysis Team, consisting of six sub-teams, and two Phase-2 curation institutes at Okayama University and JAMSTEC Kochi Institute for Core Sample Research.

Reports from the six teams involved in the initial analysis are to be published in scientific journals. Some of these have already been published in **Nature (Astronomy) 2022**.

One international facility used in the project was the Nanoprobe beamline (I14) at the UK's synchrotron radiation source, Diamond. X-ray Absorption Near Edge Spectroscopy (XANES) was used to map out the chemical states of the elements within a fragment of the asteroid material. This enabled a detailed examination of its composition.

FORTHCOMING CONFERENCES 2023

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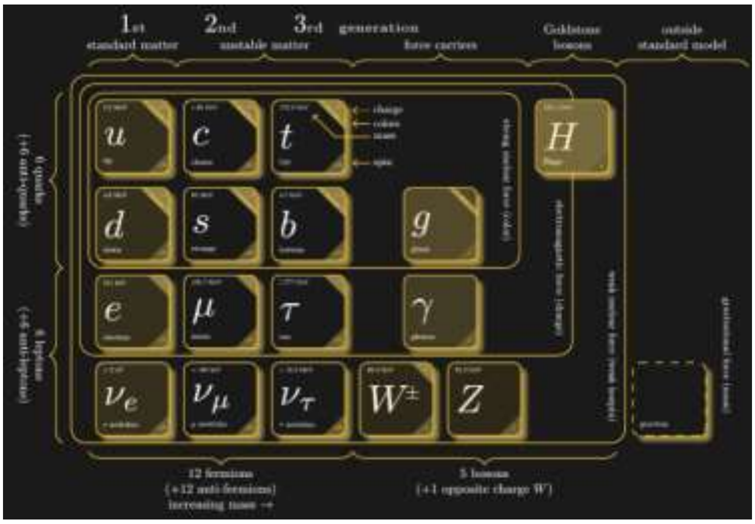
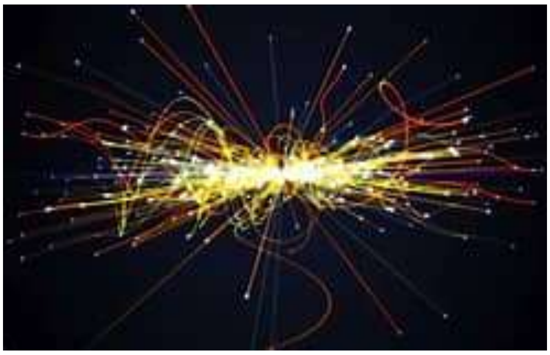
On 5 July 2022 it was announced that CERN's *Large Hadron Collider fired up for the 3rd time to unlock secrets of the Universe.* **(Katie Hunt CNN 5 July 2022).** This rather grandiose statement was followed by other press releases with impressive headlines such as *CERN Physicists find evidence of three new "exotic" particles* (**Vishwam Sankaram Independent/topic/large/hadron/collider November 2022**), *59 new hadrons and counting* (**Piotr Traczyk CERN Accelerating Science 3 March 2021**), and others suggesting that the existence of exotic particles which they have found indicate a breakdown of the Standard Model of Elementary Particles. In an earlier commentary in this section of the IRPS Bulletin (**D Creagh 2022 IRPS Bulletin 35_2_p16**) I presented a figure similar to the one shown below. This shows the present understanding of what are the elementary (or fundamental) particles-- the building blocks from which nuclei are built---as opposed to **fragments** which are conglomerates of these elementary particles, which are usually evanescent, with short lifetimes (~10^{-15}sec or less). These are referred to as hadrons, and there are two types of hadrons: baryons and mesons. **Baryons** comprise three coloured quarks each of which carries a charge, the nett sum of the charges being integral (0 or 1). **Mesons** comprise one quark and one antiquark. The force entity which binds the quarks together is a **gluon**.



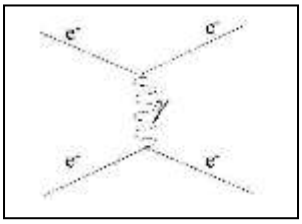
From Large Hadron Collider Website

The analysis of the data resulting from a particular proton-antiproton collision is difficult not only because of the number of possible interaction products which may occur but also the need to detect these in a very short timescale. For each collision a large number of baryons are produced. Their trajectories are recorded in the detector and as they travel, they decay into smaller entities, which in turn decay into smaller entities, and so on. A typical interaction image can be seen in the nearby image taken of a B-meson decay at the CDF at the Fermilab. For each trajectory the origin of the particle must be found and then the decay products must be identified, taking into account the laws pertaining to the conservation of energy, momentum, angular momentum, charge, and other considerations, such as isospin.



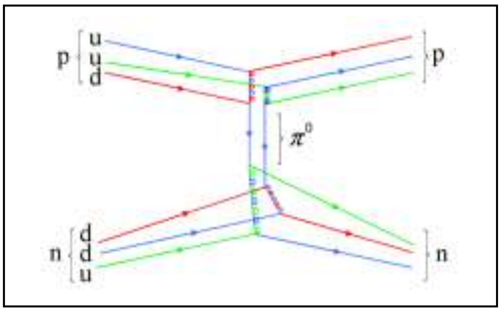
The question of charge conservation is taken into account in QuantumChromodynamics (QCD) by the assignation of colour to each of the quarks in a baryon. A baryon contains three coloured quarks: blue, red, and green. By contrast, a meson contains two quarks: green and anti-green. Interactions between quarks in a particle occur through the mediation of the gluon. The concept underlying the interaction is simple.

Think of two people throwing a football from one to another. When one of them throws he recoils as he projects the ball. The second catches the ball, and as a result moves absorbing the balls momentum, and instantaneously throws the ball back, moving still further. On receipt of the ball the initial thrower moves to absorb the momentum of the ball. A simple example of this scenario is the Quantum Electrodynamics (QED) description of electron-electron scattering using the Feynman diagram (below). Here the force is the electrodynamic force and the



interaction is the interchange of a γ-ray between the two electrons. The γ-ray photon is massless (but it carries momentum since it has an energy) and the distance between the two electrons can be large: the force diminishes as $\sim 1/r^2$.

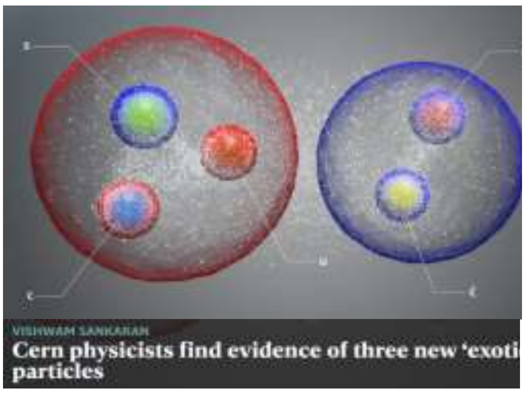
Applying the ball-throwing analogy to the case where the ball is a medicine ball, which is very much heavier than a football, it will be observed that the distance over which an interaction can take place is limited: the heavier the force carrying particle is, the shorter the range of the force. It is not easy to create a Feynman diagram for a QCD description of even such a simple system as the interaction of a proton and a neutron. Each of these contains three quarks which are bound by 3 gluons. The figure below is an attempt describe the interaction. The proton contains 2 up-quarks and 1 down-quark—so it has a charge of +1 and is coloured white (R+G+B =W). The neutron contains 1 up-quark and 2 down-quarks – so it has a charge of 0 and a colour charge of green. During the interactions the particle which is exchanged is a π^0 meson, which comprises 1 quark and 1 antiquark and has a mass of 100GeV/mc^2 and a lifetime of 8.5 X 10^{-17} seconds in its free state.



In its free state it decays into 2 γ-rays. Following the colours in the figure along each trajectory it is possible to get an understanding of what is happening to the quarks in the proton and the neutron individually. Computations using QCD are very complex, complicated by the fact that gluons have colour and can self-interact. QCD calculations assume that all the charge of a proton is physically contained within its volume, as measured experimentally. (**D Creagh 2022 IRPS Bulletin 35_2_p16**).

Fragments/particles

Returning to a discussion of actual proton-antiproton collision data. One regularly sees press releases like the one shown in the picture, below. These are the QCD calculations for what the



contents of the fragments resulting from an experiment at CERN might be. (**Vishwan Sanharam CERN News 7 December 2022**). The picture shows two tetraquarks. On the left the illustration shows a group of singly bound quarks: a charm quark (c), a strange antiquark (s), an up-quark (u). The QCD simulation on the right comprises a charm anti-quark (c), and a down-quark (d).

These are pictorial representations of the most recent of exotic particles detected. An earlier press release by CERN was entitled *59 new hadrons and counting* (**CERN News 18 November 2022**

Continued :

One wonders how many of these ephemeral fragments will be found in the detritus of the collision process as experimentation progresses. And what new physical insights will be gained therefrom.

Sabine Hossenfelder, who has worked in the Particle Physics field and is currently employed by the Frankfurt Institute of Advanced Studies, has caused a stir by daring to ask questions on this subject. The response has been a concerted attack on her on social media. I would have thought that there would have been a rebuttal of her assertions at the highest academic and institutional levels, but I am not aware that this has occurred.

Particle spat

Physicist and author Sabine Hossenfelde from the Frankfurt Institute for Advanced Studies has caused a bit of a stir after penning an opinion piece for th *Guardian*. She branded the race to creat new particles as "useless", claiming that since the 1980s physicists have invented "entire particle zoo" that experimentalis have failed to spot. Cue an outcry on Twitter with Hossenfelder publishing a blog post on her website responding to tl responses. "Theory development should focus on resolving inconsistencies, and stop wasting time on pseudo-problems," she fizzed. "Particle physicists don't like the idea that they have to change. Their responses are boringly predictable." One Tweet suggested that Hossenfelder wrote the *Guardian* piece to help sell he latest book, a comment that received a swift rebuke. "If you want to sell books, I recommend you don't write them about theoretical high-energy physics," she said "It's not a topic that has a huge market." Strange, as her latest book is a *New York Times* bestseller.

(**Physics World Quanta November 2022_p3**).

A myriad of scientific problems in nuclear and particle physics remains to be solved. Let us try to solve some of these before we invest money and time into following fanciful theories.

One of these problems is the question: what is the radius of the proton?

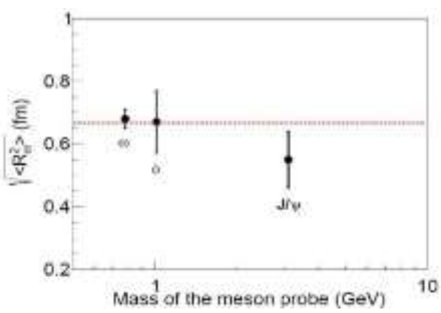
The radius of the proton…..revisited

In Frontiers (**Physics World December 2022_p3**) the headline is ***Conflict grows over the proton's structure.***

In the previous edition of the IRPS Bulletin (**2022 35_2_p18**) I presented the experimental determinations of the radius of the proton using three different methods.

The value for the radius of the proton, recognized as the official (CODATA) value, is based on momentum transfer measurements at the University of Mainz, which found the radius to be 0.895×10^{-15} m. However, using dispersion relation techniques Meissner found a lower figure (0.847×10^{-15} m). (**D Creagh IRPS Bulletin 34 2 p14**).

More recently, the **charge radius** of the proton was measured precisely by scientists using Lamb shift of the muonic hydrogen and high energy electron-proton elastic scattering, The charge radius was found to be $\mathbf{0.8409 \pm 0.0004}\ 10^{-15}$ m.



But a research group at the Institute of Modern Physics (IMP) of the Chinese Academy of Sciences (CAS) found the proton **mass radius** by investigating the vector meson (mesons with total spin +1 and odd parity) photoproduction data from the omega, phi and J/psi projects at the SAPHIR (Spectrometer Arrangement for PHoton Induced Reactions) experiment at Bonn University, the LEPS (Laser Electron Photons) experiment at SPring-8 facility, and the GlueX experiment at Jefferson Laboratory. From these data sources they determined the **both scalar gravitational form factor** and the **proton mass radius**.

The **proton mass radius** was estimated to be $\mathbf{0.67 \pm 0.03}\ 10^{-15}$ m. (**Wang et al 2022 Phys Rev D 105 096033 27 May**). A similar theoretical study by Prof. Dmitri Kharzeev yielded a comparable result using the GlueX J/psi data. He estimated the proton **mass radius** to be $\mathbf{0.55 \pm 0.03} \times 10^{-15}$ m. (D Kjarzeev 2022 Rev Mod Phys 94 015002 21 Jan).

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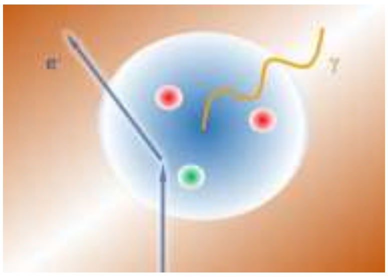
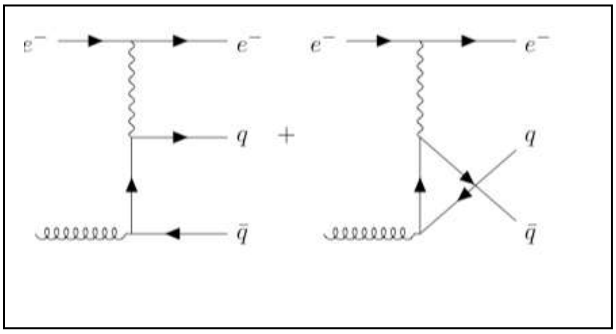
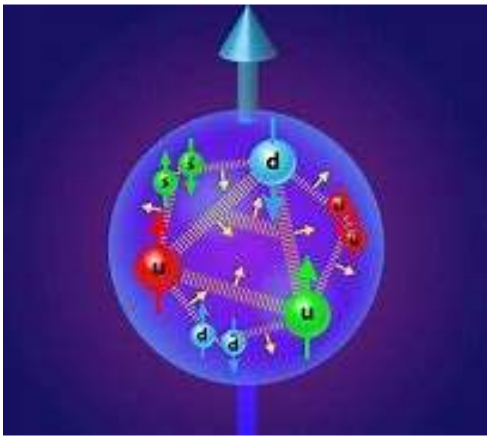
The conflict referred to arises because recent measurements, made using an electron scattering technique in which an electron beam is fired at liquid hydrogen, give *surprising results*.



(**Sparveris** ***et al*** **2022 Nature 611_pp265-270**). The electron beam is inelastically scattered by the proton and the interaction process produces a γ-ray. Measurement of the angular and energy distributions of the γ-rays gives information on the polarizability of the nucleus. The polarization should decrease with the depth of penetration. Instead, a small bump was seen in the polarization versus depth curve. Spareveris commented that, "*If the proton is assumed to have its conventional structure, the experimental data appears inconsistent with the scattering pattern predicted by chiral effective field theory*". The Chiral Effective Field Theory is constructed with a Lagrangian consistent with the (**approximate**) chiral symmetry of quantum chromodynamics (QCD), as well as the other symmetries of parity and charge conjugation. Its use is necessitated by the fact that the gluons affect the polarization process non-linearly and conventional QCD computations become impossibly complicated.

The electron carries a charge of -1 and it interacts with each of the two up-quarks (+2/3) and the down quark (-1/3) both by electrostatic attraction and the weak nuclear force. In the static case, as shown above, the depth of penetration is easy to compute. But within the proton sphere the quarks and gluons are in constant motion so any calculation requires the use of statistical dynamics. If the electrons are elastically scattered no nett energy is transferred to the proton as a whole. But if inelastic scattering occurs a force mediating particle must be present. This particle is a photon. It interacts with the gluons (there are three of these but the gluons each have colour charges) as well as the quarks. The nature of the electron-gluon interaction is unclear.





A schematic diagram of what might be happening inside the proton is shown on the left. There are many couplings and cross-couplings between the particles. Each electron-gluon interaction could be described by the mechanisms shown in the Feynman diagram (above). Here the gluon is represented by the helical symbol. The wavy line represents a photon, acting as the force carrier between the electrons and the proton's constituents. Because the effect of the colour charge of the gluons on scattering is complicated, **approximations** have to be made using statistical mechanics.

Does it matter that the conflict exists? The answer is yes. It shows that the properties of the particle used to probe the proton's inner structure significantly influence the measurement of its radius. In this case the energy of the electron is lower than those of the mesons used in other experiments. And the interaction electrons with the nuclear entities comprising the proton are different from those involving mesons. The meson measurements suggest that the proton's mass is located towards the centre of the proton and some of the charge cloud surrounds this like a halo. Finally, the Sparveris experiment was conducted at only three electron energies.

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As Xiangdong Ji (University of Maryland) commen*ts, "the researchers have three data points, one of which looks slightly higher than the others……I think it is not a statistically meaningful measurement*."

In real terms, however, the release of the findings of what is an incomplete experiment has the effect of obscuring the messages borne by other very significant press releases.

For example: in a press release by the LHCBeauty collaboration at CERN, the news headline on the banner page of the staff news bulletin was: **CERN physicists observe a Nonzero mass difference between the charm meson and its antiparticle.** The mass difference was found to be 1 X 10^{-35}kg. Why is this important?

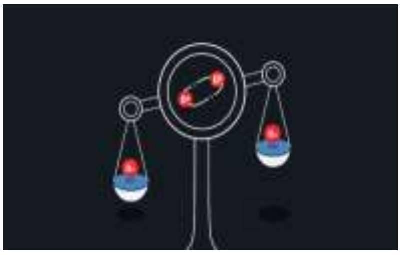

Image: physics.org

The charm (D_0) mesons are created in the Large Hadron Collider by the collision of two proton beams. They travel only a few millimetres before they decay into other particles.

The D_0 meson comprises a charm quark and an up antiquark. Its anti-particle comprises a charm antiquark and an up quark. The D_0 particle and its antiparticle can be itself (D_1) and its antiparticle (D_2) at the same time. The D_1 meson is very slightly lighter than the D_2 meson. The meson oscillates between the D_1 and D_2 states. (**CERN Courier 27 June 2021**)

Think of this in terms of a simple beam balance experiment in which the D_1 and D_2 particles in different pans on a beam balance which is set in motion by some small force. Because there is little difference in mass the beam rocks to and fro between the states for as long as the D_0 meson exists (415 x 10^{-15} s). The mass difference between the D_1 and D_2 mesons can be measured because the lighter D_1 meson travels further than the D_2 meson before decaying into other particles.

In the LHCBeauty press release it was remarked that, "*It is believed that by studying mesons like the D_0 meson an insight might be gained which would enable the imbalance between the number of particles and the number of antiparticles in the university to be explained*".

According to the Big Bang theory the number of particles should be equal to the number of antiparticles.

Astronomers have released a gargantuan survey of the galactic plane of the Milky Way. The new dataset contains a staggering 3.32 billion celestial objects -- arguably the largest such catalog so far. Credit: DECaPS2/DOE/FNAL/DECam/CTIO/NOIRLab/NSF/AURA, Image processing: M. Zamani & D. de Martin (NSF's NOIRLab)

Whilst application of the current laws of physics and its associated axioms has led us to a better understanding of the world and how it functions, it does not necessarily explain the universe as it is evolving. In fact: the recent daily pictures from the James Webb telescope show that the universe is a complicated chaotic structure, and it is not a series of *stars fixed in the firmament*, as the Greeks believed. The image above was taken during a survey by the Dark Matter Camera of the galactic plane of the Milky Way. This data set contains at least 3.5 billion celestial objects which were not previously observed. This image shows the universe has vast diversity, with no semblance of order or structure: seemingly there is turmoil everywhere one looks.

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The charm oscillation experiment is but one small (but important) piece in the huge jigsaw puzzle which is our universe.

And another thing…….

To change the direction of this section completely, I want to introduce you to the study of volcanoes---specifically one large eruption which occurred in Tonga exactly one year ago (15 January 2022). The techniques used involve satellite imagery and multi-beam SONAR techniques to study the shape of the eruption, and a wide range of analytical techniques of the types one would find discussed at an IRRMA conference, to study the debris ejected in the eruption.

The eruption emanated from a dormant volcano the top of which lay under hundreds of metres of water. The tiny Kingdom of Tonga is located in a region in which a chain of inactive volcanoes rises from the ocean depths. Some of these rose above the sea and became inhabited by people fleeing the Great Ice Ace (110,000 to 12,000 BCE). Others lie submerged. Those near Tonga, lie along tectonic plate lines in the so-called *Ring of Fire*.

The location of the island group to which Tonga belongs is circled in the map (above). Whilst much is known about volcanoes such as Mount St Helens (USA), Mount Fuji (Japan), and Mount Merapi (Indonesia) because they are surface volcanoes, little is known about seamount volcanoes because they lie below the ocean surface. There are many of these, and their intermittent activity causes earthquake damage and tsunamis to the region in which they are located. The Kobe earthquake (1995) and the Fukushima tsunami (2011) were caused by shallow volcanic eruptions.

The Hunga Tonga-Hunga Ha'apai volcano is the most violent volcanic eruption ever observed. The cloud of ash and water reached high (~58km) into the atmosphere, penetrating high into the mesosphere, punching a large hole in the Ozone layer (15-35 km), and almost reaching the lower D-layer of the ionosphere (~70km).

The arrow on the satellite photograph (shown on the left), taken shortly after the eruption, shows the disturbance caused to the atmosphere by the eruption. The eruption created a deep hole in the caldera of the volcano with an estimated **7.1cubic kilometres** of magma being ejected. (***S Cronin 2023 Asia Paciific Report 15 January 2023***). Magma is the semi-molten and molten rock which lies under the earth's crust. The amount of seawater propelled into the air would have been of commensurate volume.

Multi-beam SONAR techniques were used to map the caldera of the volcano three months after the eruption. Researchers were surprised to find it to be remarkably intact. Before the eruption the top of the sea-mount had been flat, and after the eruption a hole 4km in diameter and 1km deep was left in the sea-mount.

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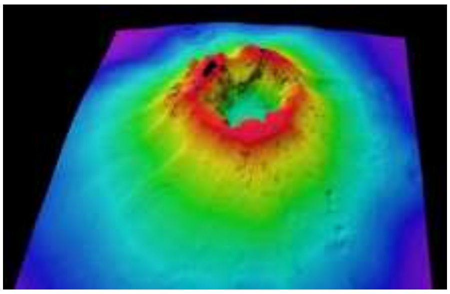


Multibeam SONAR Image of the caldera: Sung-Hyun Park: Korean Polar Research

Examination of the volcanic ash using the analytical techniques available (microscopy, texture analysis, xrf, xrd, *etc*) and isotopic *fingerprinting* using lead, neodymium, uranium and strontium, showed that at least three magma sources were involved. Radium isotope analysis indicated that two magma bodies were older and resident in the Earth's crust. Later they were joined by a new source, exact origin unknown. Mingling of the magmas initiated a strong reaction, which drove water and what are called *volatile elements* out of solution and into gas. These interactions caused bubbles, and then foam, to develop.

This intermediate material (called *andesite*) which formed has low viscosity. It was forced out through fissures in the rock which caused the rock 5 to 10 km below the surface to fracture, leading ultimately to the collapse of the caldera. The high-pressure collapse of the caldera led to a violent interaction with the sea water with the 1150^0C *andesite*, and caused two explosions about 40 minutes into the eruption. Each of these further released pressure from the underlying magma, amplifying the bubble growth.

After an hour the pressure causing the ejection of material diminished and widespread pyroclastic flows ensued. These flows damaged large areas of the seabed, killing the fish and destroying their habitats, and disrupting communication by destroying international and local data communication cables. The effect on the atmosphere can be seen in the earlier picture—the cloud cover has been displaced away from the plume by the shock waves created by the eruption. The hole in the Ozone Layer will take some time to close up.

This event has a historical parallel—the Krakatoa eruption (Sunda Strait, Indonesia 1883).
On the face of it, the Tonga eruption is a tragic but infrequent event which destroyed lives and damaged property. But worldwide there has been an increase in volcanic since 1600 CE (https://volcano.si.edu/reports_weekly.cfm) suggesting that seismic instability related to tectonic plate movement has been increasing for some time. Volcanic activity in 2022 included the Fagradalsfjall volcano in Iceland, Mount Anak Krakatau in Indonesia, the Fuego volcano in Guatemala, Hunga Tonga-Hunga Ha'apai in Tonga, Mauna Loa in Hawaii, Mount Etna in Sicily, the Shiveluch volcano in Russia……….and more.

Given these eruptions eject large amounts of particulate material, gases, and in the case of submarine volcanoes, water, into the atmosphere., the effect of volcanic activity on weather in the regions surrounding the volcanoes cannot be ignored.

Further information gained by a study of the seismic waves generated by on the Tongan eruption can be found on the web.(https://phys.org/news/2023-01-solid-earth-atmosphere-interaction-hunga-tonga-hunga.html).

So: is another submarine volcanic eruption likely to occur? And if so, when?

Scientists using a new imaging technique have discovered a volcanic activity along a section of the caldera of an active volcano, Kolumbo. Kolumbo is situated 7km from Santorini (in the Cyclades Island group, Greece) and the caldera lies 500m under the surface of the Mediterranean Sea. In 1650BCE the island Thera (Santorini) was almost completely destroyed by an eruption. What can be seen in the map on the left are the remnants of the Thera volcano. This caused

Continued :

significant destruction to the Minoan community, with damage extending as far as Crete. Kolumbo erupted again in 1650CE causing significant damage to the region, especially to agricultural production, and depletion of fish stocks on which the communities were almost completely dependent.

The new technique uses an array of seismic detectors located on the seafloor receiving the sonic waves caused by air-gun blasts emitted from a vessel traversing the area.

Submarine volcanic activity along a section of the Kolumbo crater on the seafloor, observed with SANT…

Examination of the seismic recorder data gives detailed information of the structure under the surface of the volcano.

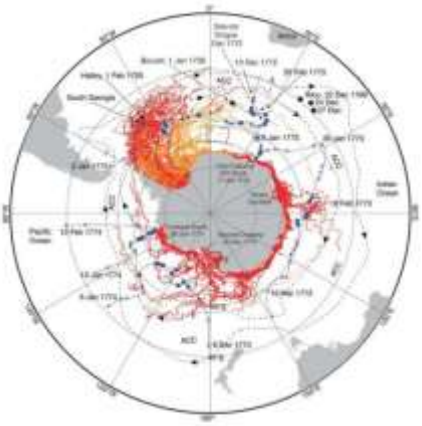
Analytical approaches, similar to those used in medical ultrasound, were used to deconvolute the data. (**G Crapkiewkcz 2023: reported by K Steinke in Physics.org 12 January 2023**).

Crapkiewkcz found that a large magma chamber has been growing at the rate of 4 x 10^6 m^3/year.

The present magma reservoir under the surface has a volume of 1.4 x 10^9 m^3. This must be compared with the volume estimated for the 1650CE eruption, estimated to be 2 x10^9 m^3. At the present rate of growth, a large sub-sea eruption could take place in the next 150 years.

Scientists should learn from past events

Historical information can be important to modern experimental scientists. An example of this is a recent correlation of the 18th Century journal of English navigator Captain James Cook's voyages to the Southern Oceans with satellite and spacecraft images taken by NASA. (**Todd Hollingsworth (Brigham Young University in association with the NASA Jet Propulsion Laboratory: reported in Phys.org 11 January 2023)**)



The historical information was taken from Cook's log books. Cook used a Larcum Kendall H1 timepiece (at that stage the only timepiece with sufficient accuracy to make the longitude measurements) and a sextant. The voyage of his vessel, the HMS Resolution, spanned the years 1772 to 1775.

The red areas show the BYU/NIC data; the orange areas the AWI data; and the blue areas the Halley, Bouvet and Riou data.

The locations of the icebergs have remained the same for some 250 years. The authors are at pains to say that they make no claims about the relevance of their work to Climate Change, but they urge people to think about their report implies…and draw their own conclusions.

What has happened in the past needs to be considered in many scientific discussions. One simple example will suffice. In the year 997CE the Norse Viking leader, Eric the Red, attempted to set up a colony in America. Prior to this the Vikings had settled in the Land of Ice and Fire (Iceland) and as well, in Greenland (992CE). The Norse settlement in Greenland existed until the 14th Century when the onset of the Little Ice Age made farming unsustainable.

In recent years the Greenland ice sheet is receding, and Greenland is becoming green again. *Note that the IPCC insists that the Little Ice Age did not exist as a global event (IPCC 3rd Assessment 2001). "Thus current evidence does not support globally synchronous periods of anomalous cold or warmth over this interval, and the conventional terms of "Little Ice Age" and*

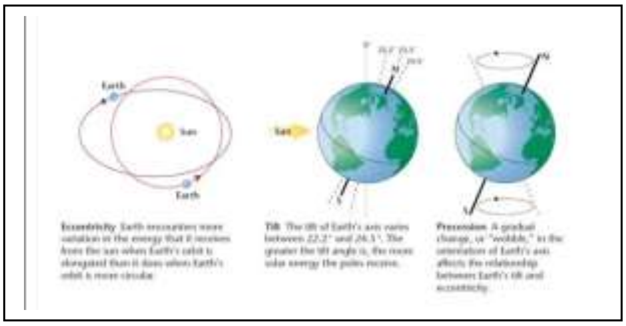
Continued :

Image: Wikipedia

appear to have limited utility in describing trends in hemispheric or global mean temperature changes in past centuries.........Viewed hemispherically, the "Little Ice Age" can only be considered as a modest cooling of the Northern_Hemisphere during this period of less than 1°C relative to late twentieth century levels.

On this reasoning the Great Ice Age (110,000 to 12,000 BCE) did not exist. The adjacent figure shows an artist's impression of the Earth at the peak of the glacial cover. Note that Australia and most of the Southern Hemisphere are free of glaciation. At the peak of glaciation the global average temperature is estimated to have been -6°C relative to today"s temperatures.

Evidently the concept of a global average temperature is not a good descriptor of what has actually happened to the Earth and its inhabitants in the past 60,000 years.



The several Ice Ages which the Earth has experienced are caused by the variation of solar irradiance at any point of the earth's surface which depends on the ecentricity of the earth's orbit, the tilt of the earth's axis, and precession of the earth's axis. The coupling of these motions cause the solar irradiance to vary with time. This relationship was first proposed by Milankovitch (Milankovitch, M. (1941) Kanon der Erdbestrahlungen, Royal Serbian Academy, Belgrade).

An early experiment which examined deep-sea sediment cores found that Milankovitch cycles correspond with periods of major climate change over the past 450,000 years, and that Ice Ages occurred when Earth was undergoing different stages of orbital variation. A review of studies on this topic was published in 2016 (MA Maslin 2016 Nature 540(7632):208-210;DOI:10.1058/540208).

It has been demonstrated that the Milankovitch Effect explains the origin of the Ice Ages. The effect of variations in solar irradiance including the solar cycle, solar flares, *etc*, need to be taken into account to modernize Milankovitch's theory.

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Commentary by Dudley Creagh.

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NEWS FLASH

Recent publications from the MINERvA project at the Fermilab confirm the fact that there are two separate radii for the proton: one associated with the gravitational force, and the other related to the Weak Nuclear Force. The proton looks like a hairy billiard ball, and particles which interact with the proton via the Weak Force (electrons)sense the outer radius (0.877×10^{-15}m). Those interacting with the strong force (neutrinos) see the inner radius ((0.73 ± 0.17) $\times 10^{-15}$m) .

(T.Marc media@fnla 1 February 2023)

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International Radiation Physics Society

The primary objective of the International Radiation Physics Society (IRPS) is to promote the global exchange and integration of scientific information pertaining to the interdisciplinary subject of radiation physics, including the promotion of (i) theoretical and experimental research in radiation physics, (ii) investigation of physical aspects of interactions of radiations with living systems, (iii) education in radiation physics, and (iv) utilization of radiations for peaceful purposes.

The Constitution of the IRPS defines Radiation Physics as "the branch of science which deals with the physical aspects of interactions of radiations (both electromagnetic and particulate) with,." It thus differs in emphasis both from atomic and nuclear physics and from radiation biology and medicine, instead focusing on the radiations.

The International Radiation Physics Society (IRPS) was founded in 1985 in Ferrara, Italy at the 3rd International Symposium on Radiation Physics (ISRP-3, 1985), following Symposia in Calcutta, India (ISRP-1, 1974) and in Penang, Malaysia (ISRP-2, 1982). Further Symposia have been held in Sao Paulo, Brazil (ISRP-4, 1988), Dubrovnik, Croatia (ISRP-5, 1991) Rabat, Morocco (1SRP-6, 1994), Jaipur, India (ISRP-7, 1997), Prague, Czech Republic (ISRP-8, 2000), Cape Town, South Africa (ISRP-9, 2003), Coimbra, Portugal (ISRP-10, 2006), Australia (ISRP-11, 2009), Rio de Janeiro, Brazil (ISRP-12, 2012), Beijing, P.R.China (ISRP-13, 2015), and Córdoba, Argentina (ISRP-14, 2018), Malaysia (ISRP-15, 2021), *and next* Portugal (ISRP-16, 2024)

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