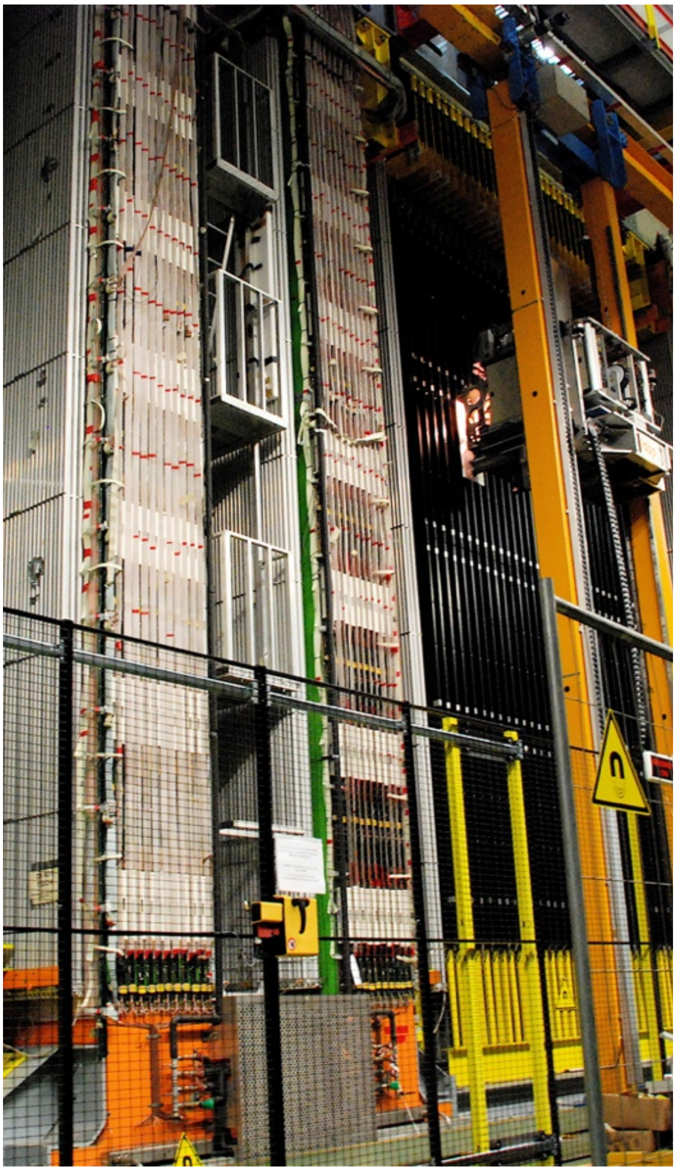
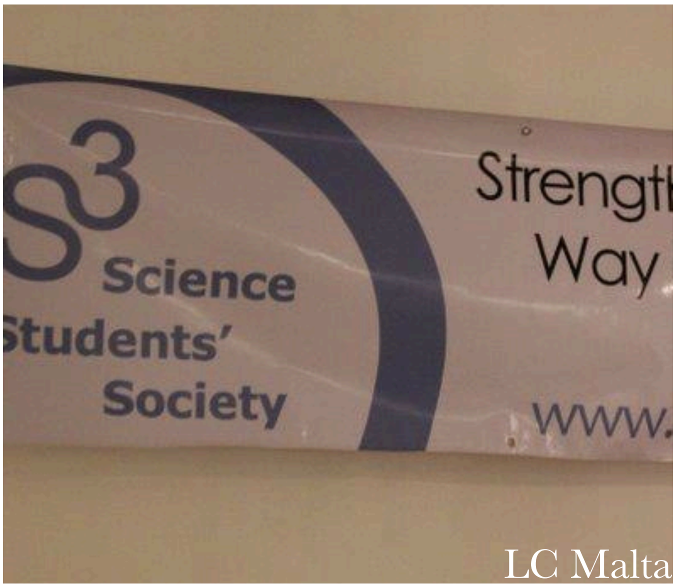
WINTER 2011/2

Chill and do Physics

The cool edition is here

{jIAPS}





LC Malta

{ICPS}

A new EC

Contents

{iaps}

international association of physics students

Editor's Note

By Norbert Bonnici (norbert@jiaps.org)

Dear readers of jIAPS, welcome to a new year of hard work. Hope you all had a great start, and are well prepared for the following examinations.

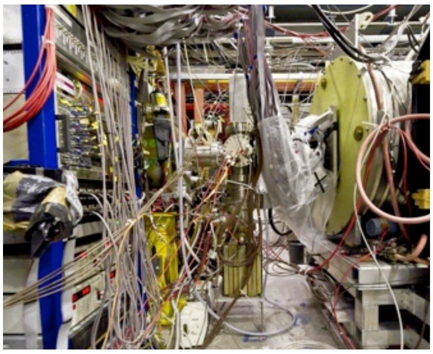
As you can see, jIAPS is getting bigger year by year, much like our beloved expanding universe. We will (hopefully) be publishing 4 digital issues of jIAPS annually and finally a printed edition with the best articles, which will be distributed at {ICPS} as usual.

In addition, this year we started interviewing physicists. Cooler people will follow in the next issues.

Hope you all like the new layout and tell all your friends about this issue.

Anyone interested in writing an article related to physics to be published in this journal, please send us an email at editors@jiaps.org If you have any comments or suggestions, please send them to the same email from above, or feel free to contact me directly.

Deltas



OPERA Experiment
Possible neutrinos over the Einstein defined speed limit...

at 125GeV - a new boson to the family
Now we think where mass comes from, and yes mass, does not come from storks....

IAPS Updates

By Bence Ferdinandy president@iaps.info

Although it is not at all easy to run an organisation when there are only nine of you, and you only see each other three times a year, we have been keeping ourselves busy as much as we could, since September. To countermeasure this, for one, we have increased the number of online meetings to once every two weeks, so by the time you are reading this, we will have had nine meetings, including the one in Mulhouse. For second, we have started a volunteers program, to expand the number of people whose work we can draw upon. One of the most important things we have done is that we started the IMAP (IAPS Member Action Programme) grant for our committees, about which you can read more in this issue or here. We have also started to prepare a grant helping people attend ICPS, but that is still under construction. As a communication innovation we created the IAPS-News list, where we will send out newsletters about important IAPS stuff, but very rarely, so no spam (email the ec@iaps.info to get on the list). And of course we did all the usual stuff the Executive Committee does: contacting people in places where we have no NC or LC, trying to convince them to join us, helping to advertise events and things physics students should know about, keeping in touch with EPS, preparing for the trips in the next semester, calculating finances, getting together a jIAPS and generally trying to seem smart and responsible.

EPS

The European Physical Society (EPS) is, to put it shortly and possibly very inaccurately, the European and grown-up version of IAPS. It consists of the different national physical societies of the European countries, similar to our National Committees (NCs) and is also a civil organisation like us. On the other hand there are also big differences too, for example, the EPS has a much larger budget than IAPS, which enables it to have professional staff, it is run by people with a little more experience than most of us and having a lot of professors with long titles in your membership kind of gives you more weight. And why do we like EPS? Well, there are a number of reasons. For one, they're physicists as we would like to become, but what is more important, they help us. And well, they help us a lot actually. As you may know, our headquarters, the official address of IAPS, is in Mulhouse, France, which is by pure chance the address of EPS as well. Also most of our administration is handled by EPS, they go to the court when there's change in the EC, they do administration of our bank account, and they host the first "in-person" EC meeting in Mulhouse. This helps keep the continuity if there's some problem with getting an EC together, as it has happened in the past. Also, they give us pretty large sums of money compared to the yearly membership fees, making EPS our biggest sponsor. A big thanks to EPS!

{ICPS} 2011 - Budapest, Hungary
Where physicists meet

By Norbert Bonnici

Let's pose a simple yet somewhat complex question to start this article. How can a lot of physics students meet up and have fun together while showing off their latest research? The answer is 42. It's also the answer to the Ultimate Question of Life, the Universe, and Everything. A second yet important and valid answer is ICPS which stands for the International Conference of Physics Students, which is the main event of IAPS, organized yearly by one of its member committees.

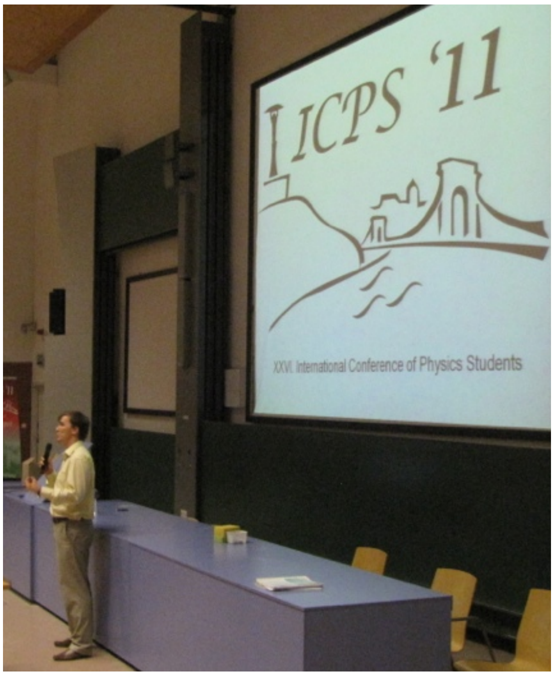
The conference started 25 years ago and was organized by students of the Eötvös Loránd University, in Budapest, Hungary in the year 1986. The main aim was to bring physics students from all around the world in one place and let them discuss their favorite subject while having fun together. Only fifty students attended the first conference, but after all those years of hard work, over four hundred students attend this annual conference.

This one week conference has its fair share of social and scientific programs. Each student gets the opportunity to listen to and give lectures on various topics in physics, visit local laboratories and make friends with physics students from all around the world. The Maltese contingency gives a lecture a year to keep the professor away. The Maltese lectures tend to be focused on astro and particle physics while the rest vary from medical physics to solid state physics, basically almost everything. Apart from student lectures, highly talented physicists give very interesting lectures.

"And yes the joke "we're hungry because we are in Hungary" was as common as an old Maltese bus B.A. (Before Arriva)"

This year ICPS took place in Budapest, Hungary, same as 25 years ago, where we had the opportunity to meet Carlo Rubbia, a Nobel-prize winner (1984) physicist who conducted research in CERN's Super Proton Collider (SPS) with Simon van der Meer and their work lead to the discovery of the W and Z bosons; who gave a lecture on sustainable innovation.

Each ICPS has its own flavor due to different cultures, especially the local cuisine. Paprika and chicken was the everyday solution to feeding 400 hungry "Hungarians". And yes the joke "we're hungry because we are in Hungary" was as common as an old Maltese bus B.A. (Before Arriva). Fortunately the joke never grew old. Culture can also be appreciated by the implementation of fun excursions with fun names. For example, this is what Budapest had to offer: Photosynthesis (swimming in a lake), Quantum Caving (small tour of a huge cave), Turbulence (boat ride on the river danube), Chain Action (walking tour to Rám Ravine) and the Crown Discharge (Buda Castle and Margaret Island).



There is no better way to and a physics filled day than with a themed party. The most prominent party is the Nation's party where the participants bring food, drinks and their traditional costume to share their culture with the rest.

Physics can never out run politics, same as no one can exceed the speed of light. During this year's 7 hour Annual General Meeting, S Cubed joined IAPS as a Local Committee, giving Malta voting rights in the meeting. During this meeting a new executive committee was appointed and Scotland won the bid to host ICPS 2013. Now you are wondering, where will it be next year? ICPSs are planned two years in advance, last year in Graz, Austria; physicists from Utrecht, Netherlands managed to win the honors to host ICPS 2012.

Hope to see some new faces at the next ICPS in the Netherlands. Anyone who is interested about ICPS 2012 can obtain more information at http://www.icps2012.com.

A New EC......
...interviewed

By Norbert Bonnici and Mischa Stocklin
Transcriptions by Anya Burkart

Bence Ferdinandy - President

From Hungary, studies at Eötvös Loránd University in Budapest. 23 years old, will finish his masters in Physics this year, writing his thesis on the spreading of viruses on networks.
Hobbies: hiking and role-playing.

Could you explain for us the origin of Bence Bence?
"Well that kind of happened at the national party when I met with the **Sheffield** people. I woke up the next morning and Facebook was all over with Bence Bence. I don't really know where they got the idea from."
Do you like the attention that this name brings to you?
"It's kind of creepy sometimes, like when they make a Facebook page for your name."

Sahra Haji - Vice - President

Originally from Somalia and later moved to England, just graduated in Medical Physics at University College London, did a summer project involving x-ray photoelectron spectroscopy, 22 and 9 months old.
Likes food and jazz, learning to glide but watches too much American TV.

When and where was your last romantic dinner?
"Erm... I have never had one of those, nowhere actually. It's **inexistent**. It is like the square root of -1."
Do you prefer Marie Curie or Brad Pitt?
"**Brad Pitt.**"
Why?
"I don't know actually. You see, does he have any intelligence?"

Ralph Lenssen - Treasurer

Born in Scotland and moved to the Netherlands at the age of 10, 23 years old, studies at Leiden University, currently in the last phase of his masters research project on multilayer UV mirrors.
Enjoys playing the guitar.

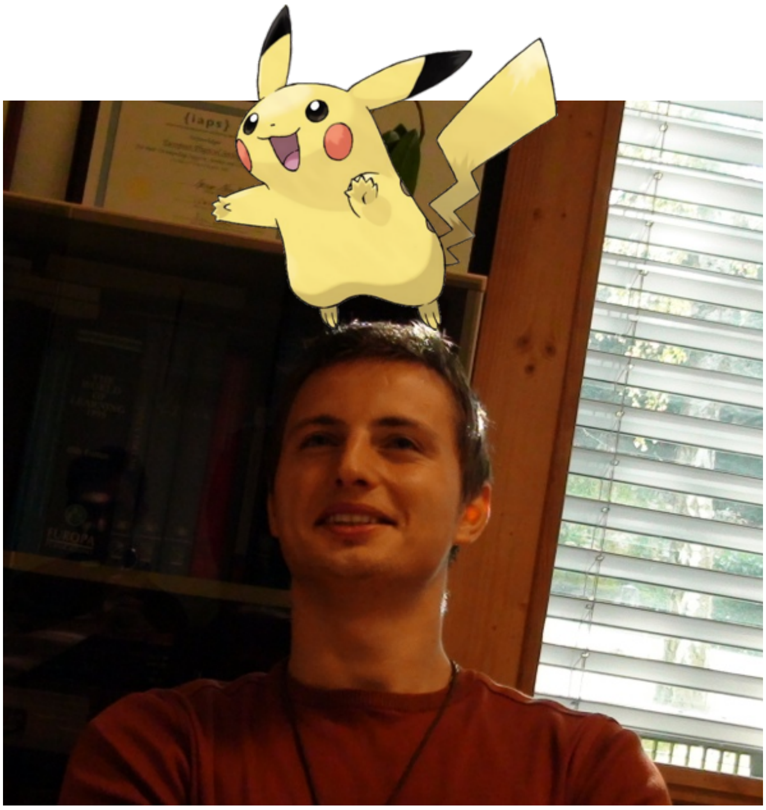
How is IAPS doing financially?
"At the moment, if you compare it to other institutions like Greece or the USA, we are doing, I believe, about **2000%** better than the average."
What about compared to the UBS?
"Well, they have not found any **fraudulence** yet (in our account), but our auditor is doing his best on finding the fraud."
How much IAPS money do you have in your own bank account?
"I have a bank account in the **Cayman islands** and it's registered on some dead guy's name, but I have access to it, so I usually put the money there."

Thomas Kotzott - Secretary

From Hamburg, Germany, 21 years old, studies at the University of Göttingen, currently in his third year of bachelors degree.
Likes to make music.

How do you make music?
"I play the **piano** and the **pipe organ**, also for time to time in church. Now I joined the University choir and I am **singing** there."
What does Hochklappdings mean?
"It's not a real word but it is something understandable in German which is something you can put up. It's also an advert for a band which had a **song** called *Hochklappdings*"

Dragos Carabet - EC Member



From Romania, 23 years old, studying at the University of Marseille, doing a masters in particle physics.
Likes to listen to music, going out with friends, meeting new people, traveling and did skydiving and kickboxing.

What's your favorite Pokémon?

"I wouldn't say anything because I don't have a favorite Pokémon. I heard a lot about it, but I **never** watched it."

No vague preferences?

"I like **the yellow one** (Pikachu). That's the only one that I know."

Mac or PC?

"**Mac** for the design. If I want performance, I would probably choose PC, but Mac, obviously for the design."

Sander Smink - EC Member

From the Netherlands, 20 years old, studies at the University of Twente, in his 5th year of Bachelors, concentrating on fluid physics. "Fluid physics could really revolutionize the world. When you have a sink and you drain water, it goes either clockwise or counter-clockwise and no one knows why. This process determines how much pollution your environment is susceptible to. Thus I think it's very important that we continue researching this subject."
Hobbies: scouting, playing computer games. plays rugby, rowing, write poems in Dutch.

So Ferrari or Nobel Prize?

"That's a tough question. I mean, I've been dreaming of a Ferrari before I heard of the Nobel Prize. But with a Nobel Prize I could buy a Ferrari, so I would go with the **Nobel Prize**."

Your favorite lethal weapon?

"I think, it would be a **scythe**. I could behead you over the other side of the table. I really like a scythe. I don't like those guns that you can shoot around the corner. They're cool, but they are not really my idea of a lethal weapon."

Anatolii Koval' - EC Member

From Kiev, Ukraine, 21 years old, studying at the State University of Taras Shevchenko, doing a satellite data analysis at the Space Research Institute, currently working with ionosphere data from satellite Sich-2 launched 17 of August 2011.
Likes to couch-surf & hitchhike (which was how he traveled to ICPS 2011 from Kiev), write short fairytales, and listen to music while coding (C++ or Python).

What is the current uptime of the {iaps} website?

"Our server shows a 100% up-time for 497 days. But if we consider the measuring accuracy (0.05%), we get that our website could have been offline for about 5h 57m during this period and my active experiments which in sum would takes about 6h. Thus it is **about 99.9%**"

What is the ideal amount of vodka?

"It depends on the method which you use to fight the enemy. You can drink like a mini-gun (many shots in a few minutes), or save money by drinking small portions. Mixing vodka and beer similar to a sine function will help you get drunk faster. **400g** is the ideal amount for students, and here some **tips** for beginners:

1. Do not decrease the above,
2. Do not forget about snacks!"

And where do you prefer to drink it?

"I don't like vodka that much, as I **prefer beer**. Vodka is for when you need to get drunk **without** a **hangover** (do not mix with another alcohol for this purposes). It's pretty nice with small and funny company, to relax."

Lily Chowdhury- EC Member

Born in Croatia, 23 years old, previously studied at Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, majored in programming and computer science. Now studies at The Faculty of science, University of Split. In her last year of her bachelor degree in Physics and doing a thesis on metamaterial optics.
Loves dancing, traveling, RPG PC games J, hanging out with friends and watching sci-fi movies and TV shows.

What is your favorite wavelength?

"**Radio** waves, from 300GHz to 3kHz."

And why?

"I love **music**. I danced since I was a little girl, I also like to sing, unfortunately nobody like to hear me sing."

What is the meaning of life?

"Umm meaning of life? I don't think it has a meaning, although it has a purpose. To learn, love, have fun, eat **chocolate**, be kind to people and simply enjoy it without cracking my head open thinking why." *Correct answer:* ***42***

Norbert Bonnici - jIAPS editor-in-chief

From the small island of Malta (300km south of Sicily, for those of you who don't know geography), 20 years old, studies Physics and Computer Information Systems at the one and only University of Malta, currently in his second year.
Hobbies: skateboarding and buying apple products.

So how is it for you coming from such a small island to such a large place like this for the IAPS meeting?

"It is quite empowering, I have such a huge ego, it helps me to feel more cool."

Is it nice not to have to worry about falling off the island?
"It's quite tough staying on the island, especially when you are under the influence of alcohol."
Will you use jIAPS to promote yourself?
"**Definitely**! In fact, I get a bigger picture."

Favorite physicists....

Bence: George Green

Anatolii': Nikola Tesla

Norbert: Michio Kaku

Dragos: Albert Einstein

Thomas: I don't think that I have a favorite physicist.

Sahra: Marie Curie

Ralph: Richard Feynman because of the lecture series

Sander: Stephen Hawking, Da Vinci, Erwin Schrödinger

Nicknames....

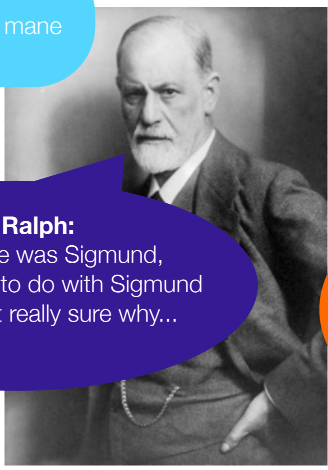
Norbert:
Norbit from the movie

Bence:
I have never had a nickname actually. I have always been called Bense [ˈbɛntsə]. Actually the only nickname I have ever had – English people think it's pronounced [bɛnts]

Thomas:
I have never had a nickname...

Dragos:
Bobby... From my other name Bogden, when I was in the US it was really hard for people to pronounce my name

Anatolii':
Bald - because of lush mane



Ralph:
My nickname was Sigmund, but has nothing to do with Sigmund Freud. I'm not really sure why...

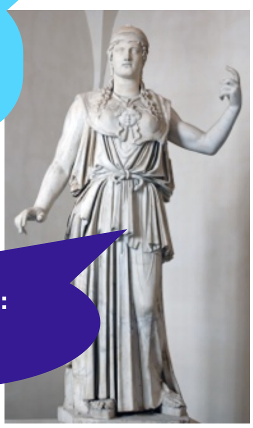
Sander:
Smink, which is my last name, people find it easy to call me that. A lot of people think it means facepaint. It's been like that just since I was 15 I think. Everybody started calling me that… You can shout it for any reason. *Smink*! Yeah, but you can usually easily say Sandra instead of Sander...

Favorite god....

Norbert:
The Flying Spaghetti Monster

Bence:
Discordia

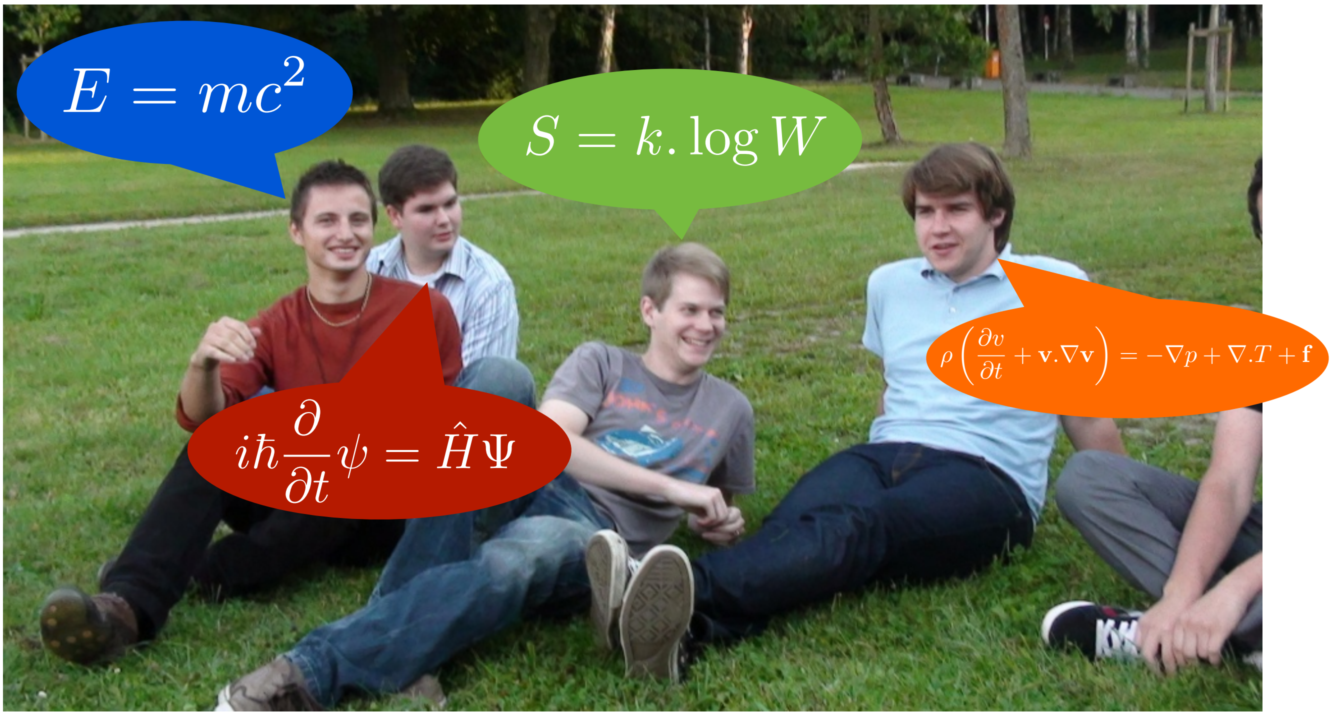
Anatolii':
Yarylo - God of the Sun from Slavic mythology



Ralph:
Athena

Sander:
Zeus

Favorite equations....



$$F = ma$$

Favorite holiday destination....

Bence: Hungary

Norbert: Rio de Janeiro, Jamaica and Hawaii

Thomas: somewhere with sea, alps and towns

Dragos: Boston, due to the ocean

Sahra: Nepal. I got to live in a house where one of my housemates taught me how to spin fire balls. Once an elephant threw me in the water and I lost my glasses, so I spent a whole week wearing prescription sunglasses because they were the only ones I had left. Hopefully I'll go back to ride more elephants and see tigers.

Ralph: Shanghai China, to visit the expensive shopping street

Anatolii': Anywhere where I can hitchhike

Sander: New Zealand, that's where Lord of the Rings was made

Favorite thing about {iaps}....

Dragos: Meetings and networks

Ralph: Make new friends

Bence: {ICPS}

Thomas: Bringing people together from all over the world, having the same interest (physics), to have a great time together.

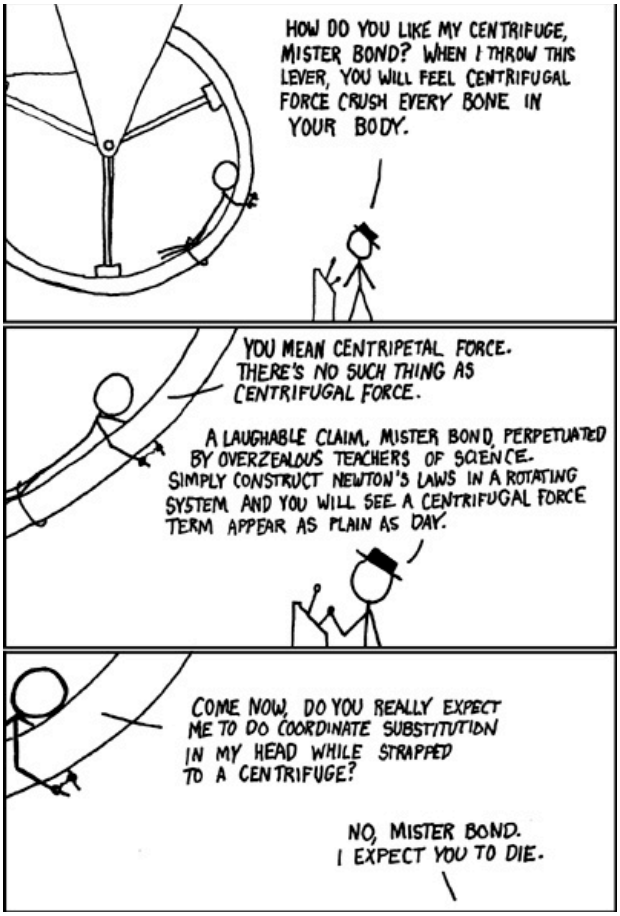
Sander: Opportunity we have to create a bigger network to help us achieve our goals

Anatolii': People who care about the physics society

Norbert: Coming from a small country, it's always great to visit larger places and meet more people who study the same subject

Sahra: Coming from a family who doesn't believe in science, it's nice to be around loads of people who like physics

FUNPAGE



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XKCD and Sudoku

Surely you are joking...

By Sahra Haji (vicepresident@iaps.info)

Physics quote of the day: Anything that doesn't *matter* has no mass.

Two atoms were walking across a road when one of them said, "I think I lost an electron!" "Really!" the other replied, "Are you sure?" "Yes, I 'm absolutely positive."

This is apparently a true story. It took place just outside of Munich, Germany. Heisenberg went for a drive and got stopped by a traffic cop. The cop asked, "Do you know how fast you were going?" Heisenberg replied, "No, but I know where I am."

Does a radioactive cat have 18 half-lives?

The Heineken Uncertainty Principle says "You can never be sure how many beers you had last night."

What did Donald Duck say in his graduate physics class?
"Quark, quark, quark!"

Einstein's favorite limerick was:

There was an old lady called Wright
who could travel much faster than light.
She departed one day
in a relative way
and returned on the previous night.

The following is a little known, true story about Albert Einstein (attributed to Paul Harvey).

Albert Einstein was just about finished his work on the theory of special relativity, when he decided to take a break and go on vacation to Mexico. So he hopped on a plane and headed to Acapulco. Each day, late in the afternoon, sporting dark sunglasses, he walked in the white Mexican sand and breathed in the fresh Pacific sea air. On the last day, he paused during his stroll to sit down on a bench and watch the Sun set. When the large orange ball was just disappearing, a last beam of light seemed to radiate toward him. The event brought him back to thinking about his physics work. "What symbol should I use for the speed of light?" he asked himself. The problem was that nearly every Greek letter had been taken for some other purpose. Just then, a beautiful Mexican woman passed by. Albert Einstein just had to say something to her. Almost out of desperation, he asked as he lowered his dark sunglasses, "Do you not zink zat zee speed of light is zery fast?" The woman smiled at Einstein (which, by the way, made his heart sink) and replied, "Si."

And know you know the rest of the story.

{iaps} Contents:
LC Malta - S Cubed

By Jake Spiteri (jakespiteri92@gmail.com)

Throughout its history, The University of Malta has been a centre of excellence in many academic fields. Without doubt, the Department of Physics within the Faculty of Science is such a case. It publishes work in areas regarding seismology, climate, electromagnetism, cosmology, instrumentation and atmospheric physics.

Since the Faculty of Science was established in 1905, science students have consistently thrived to create a society in which the students themselves could socialize and enjoy a like-minded environment between peers. Scarce evidence dating back to the 1960's brought to light a Chemical Society and Science Student Association. However, these organisations ceased to continue some years later. Nevertheless, after so many years, it was in 2003 that a small group of students founded The Science Students' Society (S-Cubed). Since then the organsation grew year after year and is currently one of the leading student organisations on campus.

S-Cubed represents all students who follow a course under the Faculty of Science (Biology, Chemistry, Mathematics, Physics, and Statistics & Operations Research). Its main aim is to unite science students through educational and social activities, which are organised regularly throughout the year. These events range from science seminars to outdoor activities, environmental initiatives to site visits and international trips. S-Cubed also works to encourage the development of an environment more conducive to the advancement of science by extending its outreach for science communication outside the university This proves beneficial to those who are interested in pursuing a science related career but are still uncertain due to a lack of information.

As most have experienced for themselves, university life can be complicated and difficult to deal with, especially during examinations. Thus, the constant presence of S-Cubed on campus provides its members the opportunity to strike a balance between coping with academic requirements and sustaining a healthy social life. During Fresher's Week, the organisation provides substantial material designed for 1st year students to ease the transition from college to university.On visiting our stand on campus, we introduce ourselves and explain the purpose of our organisation and how we can aid them throughout the academic year. During Fresher's week a number of tours are specifically addressed for new students to familiarise themselves with the science buildings, lecture theatres and the laboratories. Along these tours we emphasise the importance in engaging to make new friends, get involved and accustom themselves with the local surroundings. In order to catalyse this, S-Cubed organises social/educational events, such as the Annual Science Seminar which takes place in October.

In addition, the organisation collaborates hand in hand with the Faculty administration to link students and academic staff in an annual 'Science Gathering'.

We party hard

Throughout the event, students and lecturers can share freely their opinions and thoughts outside a formal academic environment. Hence it helps to narrow the gap which often prevails during the scholastic year.

S-Cubed publishes the magazine In Touch twice yearly with science related articles written by students and researches. The full-colour magazine aims at communicating science through informal language and provides the opportunity for students to share their experiences and interests.

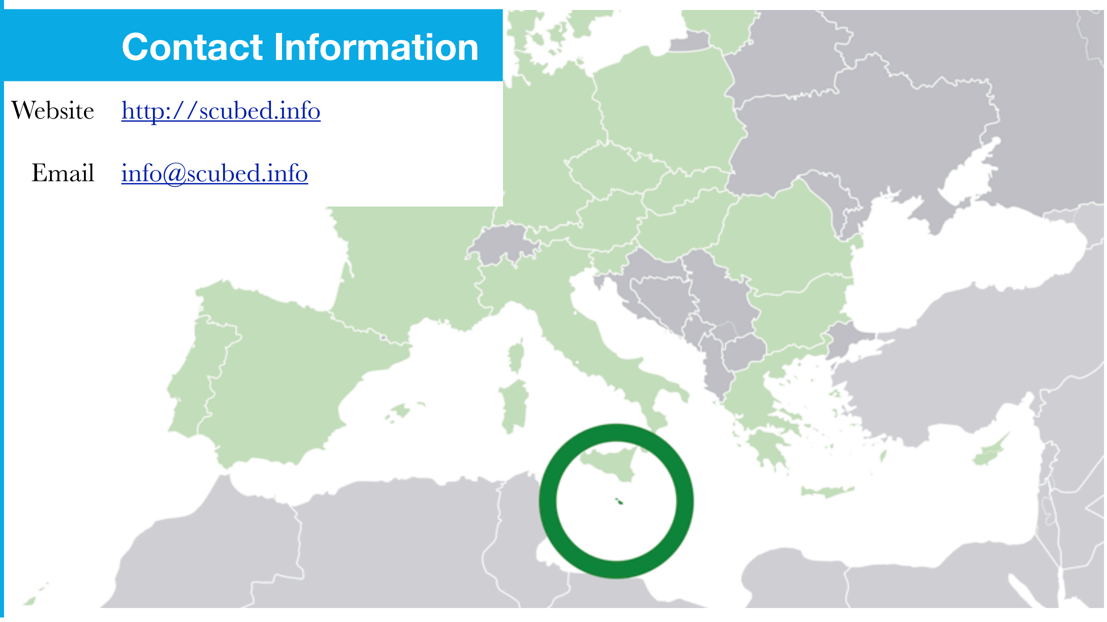
Lastly, but nonetheless important, S-Cubed coordinates informal education through talks and debates held on campus and seminars. In most cases, these talks are central to current issues and are delivered by specialists in the subject under consideration.

S-Cubed will constantly endeavour to achieve its goals and build an excelling environment for science students. In doing so, we do not only succeed in helping our members during their time on campus, but will eventually improve the recognition of research among the general public. In understanding the implications of scientific applications, our societies will be more aware in recognising sustainable advancements in science.

Contact Information

Website http://scubed.info

Email info@scubed.info



Terrestrial Impact Craters
A Short Review

By Denise De Gaetano (denise_de_gaetano@hotmail.com)

Impact craters are geological structures formed when large meteoroids, asteroids or comets collide into a planet or a satellite. A number of these structures have been recognized on Earth as Terrestrial Impact Craters. This short review investigates the occurrence of these structures on the Earth's surface, especially the most prominent ones, their geological effects, categorization, possible links with events in Earth's history, and major impact events amongst others.

Introduction

Planetary exploration has shown that virtually all planetary surfaces are cratered from the impact of interplanetary bodies. The primordial atmosphere and hydrosphere may have been generated by outgassing of Earth's initial crust, due to heat by early impacts. Additionally, the impacting bodies themselves may have contributed to the Earth's budget of volatiles. A mass extinction event notably that of the dinosaurs, which is estimated to have happened about 65 million years ago, is linked to global effects. Impacts may also contribute to the economy of the particular impact site such as the vast copper-nickel deposits at Sudbury, Canada which are likely a related result of a large-scale impact 1850 million years ago.[1] Impact structures in sedimentary rocks have also provided suitable reservoirs for economic oil and gas deposits. An impact crater is "an approximately circular depression, sometimes surrounded by a raised rim. Craters are typically formed by explosion during meteorite impact".[2] A palimpsest of a crater is left behind when an ancient crater relief disappears. It might be assumed that a major impact on Earth would leave behind unmistakable evidence, but infact the gradual processes that change the surface of the Earth tend to cover the effects of impacts. Erosion by wind, water, sediment and lava flow, make it difficult to study craters, since these tend to bury craters left by impacts.

Impact craters start out as circular structures bound by a raised rim and bottomed by a depression which may have a central uplift or peak. By time craters wear down to scars also known as astroblemes. These still include the in situ features of craters, namely shatter cones and breccias. Figure 1 illustrates the stages in the formation of an impact crater. First an impact hits the ground, which forces shock waves to spread through the rock and ejecta to be thrown out of the crater.[3]

Figure 1: Stages in the formation of an impact crater: (a) the impact; (b) the projectile vaporizes and a shock wave spreads through the rock; (c) ejecta are thrown out of the crater and (d) most of the ejecta material falls back to form secondary craters, rays and the ejecta blanket.[3]

Formation and Structure of a Crater

Two primary regions make up a crater, the excavation zone and the deposition zone. The excavation zone is geologically concave. This is the region carved out by the force of the impact. The deposition zone is convex in shape. A crater is usually surrounded by an ejecta blanket, while its floor is covered with breccia, a coarse-grained rock, composed of broken rock fragments. The floor of the crater can be bowl-shaped or with a central uplift, while around it the walls form a raised rim. The target rock and the impactor both melt during an impact, forming what is called an impact melt. The majority of these craters usually form circular in shape, but a few also have a non-circular shape. The reasons for non-circular craters include the degradation or modification of the crater with age, the material strength of the target compared to the energy of the impact and the angle of impact. The average impact angle is usually around 45 degrees, making perpendicular impacts quite rare. Since most bodies in the solar system orbit the sun and each other within a plane ecliptically, the spread of impact angles isn't entirely random due to gravity well effects. The angle can have an influence on the shape of a crater, but this effect is reduced when the angle is less than 20 degrees (Figure 2). When the impact angle is less than 10 degrees, crater distortion is more noticeable.[4]

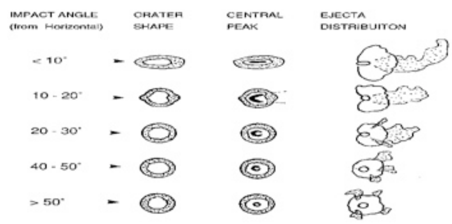


Figure 2: A visual guide to the morphology of craters and their debris peaks and ejecta at different impact angles.[4]

Crater Categorization

Crater Identification

The pressure, which can be up to 900GPa and temperatures produced upon impact are...

...sufficient to completely melt and even vaporize the impacting body and some of the target rock. In such cases, the recognition of a characteristic suite of rock and mineral deformations, termed "shock metamorphism" (Figure 3), which is uniquely produced by extreme shock pressures, is indicative of an impact origin. "Conical fractures known as shatter cones, microscopic deformation features in minerals, particularly the development of so-called planar deformation features in silicate minerals such as quartz, the occurrence of various glasses and high pressure minerals, and rocks melted by the intense heat of impact", are very common examples of shock effects.[5]

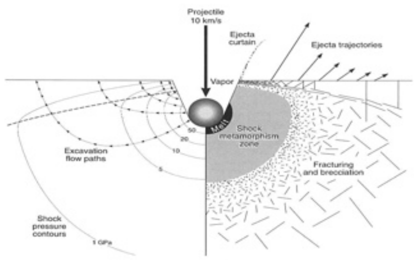


Figure 3: Diagram illustrating the shock metamorphism which occurs at an impact origin.[5]

Crater morphology

The crater diameter has a direct correlation with the morphology of impact craters. Slumping of the inner walls and rebounding of the depressed crater floor create progressively larger rim terracing and central peaks, as the crater diameter increases. Furthermore, one or more peak rings, make up larger diameters resulting in the formation of impact basins. The interiors of these structures are partially filled with breccia and rocks melted by the impact. Impact structures on Earth include two types; simple structures, which are up to 4 km in diameter, "with uplifted and overturned rim rocks, surrounding a bowl-shaped depression, partially filled by breccia and complex impact structures and basins". On the other hand, complex structures are generally 4 km or more in diameter, "with a distinct central uplift in the form of a peak, an annular trough and a slumped rim".[1]

Impact crater sizes

Craters exist in a variety of sizes. Craters up to 25 Kilometres in diameter are termed as small craters having a typical deep bowl structure (Figure 5). Surface material thrown out of the impact site leaves a classic deep hole shape surrounded by a wall of loose debris.[4]

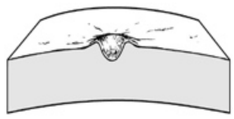


Figure 5: An illustration of a small impact crater.[4]

Medium craters are those between 25 kilometres and 130 kilometres in diameter (Figure 6). They are usually made up of a central peak and a shallow excavation zone. This is due to the fact that instead of excavating a proportional amount of material, some of the impact force is absorbed. The existence of a central peak is unique to medium size craters and is the result of matter thrust upward immediately after the impact. An enormous amount of energy is required to thrust matter upward into these "mountainous shapes". Such energy cannot be sourced from a gradual returning or reforming of the planet's surface since, rebounding must be rapid. This action catapults central matter upwards.[4]

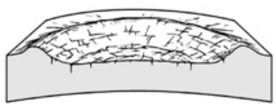


Figure 6: An illustration of a medium impact crater.[4]

Large craters are those over 130 kilometres in diameter. The floors are very shallow and convex in shape, following the planet's natural surface curvature. Their inner regions are terraced by concentric rings.[4]

Figure 7: An illustration of a large impact crater.[4]

Impact Events

Evidence for an impact catastrophe is best demonstrated by the K-T boundary, which is the time horizon between the Cretaceous [K] and Tertiary [T]. The Chicxulub impact in the Yucatan Peninsula is classified as one of the largest short-term natural events known in the geological record. This huge structure has no evident surface expression, being covered by younger sedimentary rocks. It however appears subsurface as a strong gravity anomaly. It was discovered almost accidentally through oil drilling, in which core samples, containing so-called volcanic rocks, showed distinct shock effects.

Another event is the Chesapeake Bay impact crater which was formed by a giant asteroid or comet that impacted the eastern shore of North America about 35.5 million years ago, in the late Eocene epoch. It is one of the best-preserved marine impact craters, and the second largest impact crater in the U.S. Several aspects of the Chesapeake Bay impact structure, apart from its size and preservation, make it an intriguing subject for scientific investigation. The impactor struck a rheologically layered wet target that consisted of a neritic water column, water-saturated sediments and crystalline rocks. The variations in target strength profoundly affected the excavation and collapse and the final geometry and size of the resulting crater.[7]

The most significant recorded impact in recent times was the Tunguska event, which occurred in the region of Tunguska, Russia in 1908.8 A recent terrestrial impact crater occurred on the 17th of September 2007, in Peru. A remote part of Peru was struck by a meteorite and carved a large crater that emitted noxious odours.

Conclusion

Due to constant research in the field, terrestrial impact craters are being identified almost immediately, therefore even though as has been described in this review Earth's active surface processes quickly destroy the impact record, those identified are being submitted to the Earth Impact Database. These craters can range in diameter from a few tens of metres up to about 300 km, and they also range in age from recent times to more than two billion years. Major impact structures include the Chicxulub impact, which marked the precise K-T boundary between the last rocks of the Cretaceous Period and the first sediments formed in the younger Tertiary Period and the Chesapeake Bay impact crater. Finally, as discussed in this review the hazard due to an impact crater depends primarily on the size of the meteorite impacting the Earth.

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Conformal Gravity:

Possibly the Next Revolution in Gravity Research

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The problem of gravitation in all likelihood goes back to the very first questions Man asked about the world, however to this day problems persists with our understanding of the how and why it works the way it does. What is and was clear at the time is that that mass is attracted to the ground but for a very long time indeed it was taboo to even ponder whether the dots on the sky are subject to the laws that govern this mechanism. In fact Giordano Bruno an Italian Friar was burned at the stake in 1600 for holding the view that the Sun is just one of a class of many such objects, stars, that may also harbor planets with worlds similar to this one.

Its not until Isaac Newton came along with his idea of Gravitation that the problem was given its first real empirical solution. There are scholarly disputes as to whether Newton should be accredited with first proposing the model, but as far as science is concerned the important thing is that the idea was taken on by the community. This model of how neutral matter attracts works by taking a direct proportionality with the product of the two masses in question interacting and more importantly an inverse proportion to the square of the distance between the objects, all with a gravitational coupling constant G to represent the strength of the force

$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}.$$

The inverse distance squared part is very important, if this were just an inverse relation then the Universe would have collapsed before we had a chance to evolve and on the other hand if this were a one on distance cube then the Universe would be much more sparse and objects such as the Earth would have to be much bigger to produce the gravity they do now. Another interesting part of this model is that the force measured by either object is equal which eludes to one important facet of gravity, that the force, that is the product of the mass and the resulting acceleration, must be equal for either object involved.

Alas in 1859 Newton's theory of gravitation met its first in a series of problems with astronomy at the hands of Urbain Le Verrier. The perihelion or closest point of Mercury to the Sun was found to move between every solar cycle in a way that was not predicted using Newtonian gravity. Despite quite sincere efforts the problem was not resolved in a satisfactory way until relativity came along.

Enter Einstein and his General Theory of Relativity in 1915 which revolutionized the very concept of gravity and utilized the modern techniques of describing geometry at the time. In general relativity the Universe is described as as a collection of points traversed by a four dimensional coordinate system thus linking the three dimensions of space with the time dimension. Relativity allows for this so called background fabric to be curved and twisted by means of its foundational principle, that spacetime is curved in an exact relation to the mass-energy of objects lying on it. This begs the question of how can we talk about this curvature in a precise way? Which brings us back to the ancient Greek school of Pythagoras and the theorem with its namesake

$$\Delta s^2 = 1 \times \Delta x^2 + 1 \times \Delta y^2.$$

In flat spacetime, where no mass-energy exists and spacetime is as we would imagine it namely completely flat, this relation holds, however introduce a little mass-energy and the background becomes curved as given by Einstein's General Relativity theory which can be thought of as Pythagoras' equation becoming a little off. In fact the amount that the theorem is off by lets us calculate precisely the amount of mass-energy a system has.

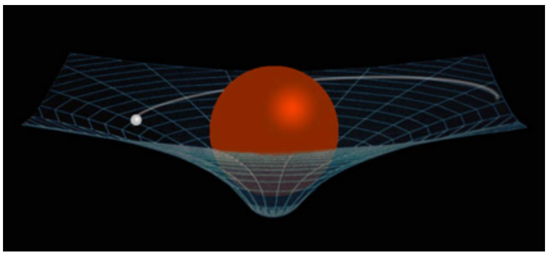

Fig 1. Curvature of spacetime.

This idea implies that there exists a background fabric that gets updated, in a sense, by changes in the mass-energy distribution about the Universe, in this way a big problem with Newtonian theory is solved, namely in general relativity we can see how gravity is felt by one object continuously. Whereas in Newtonian theory gravity is observed by a recipient object simultaneously which contradicts the speed of light information speed limit.

Again problems were found, first by Fritz Zwicky and later by many others, on the galactic scale (order of size, for galaxies this is between 1000 and 100 000 light years in general) the predicted value of angular velocity of stars rotating about the center of the galaxy, given the luminous matter observed, fell very much short of the necessary value required to produce the measured speed. The first method of resolution was to consider the Right-Hand-Side of the general relativity principle equation.

$$\text{Geometry} \equiv \text{Mass-Energy}$$

Furthermore when the Universe scale is considered an even worse scenario is discovered. In 1998 it was found observationally that the expansion of the Universe is accelerating, that is the distance between stars is becoming larger at an increasing rate! And it is not that the stars and galaxies are themselves accelerating away from each other by some means but that the very fabric of the background geometry is expanding between them and everything else.

The simpler solution is to fix the Right-Hand-Side of Eq. 3, for galaxies input a small amount of Dark Matter to make up the extra mass-energy is needed, while on the Universe scale a totally unknown substance is proposed called Dark Energy. Both of these substances are introduced to fill in a gap in our model and this gap exceeds 95% of all supposed mass-energy in the Universe.

Another way is the work on the *Geometry* part of this equivalence principle equation. Currently many researchers are exploring the possibility of adding terms to this part of the equation that only become significant at such high scales, especially in the gigantic voids between galaxies. Such ideas have shown promise however it is unclear how the choice of these terms is made in the sense of where do they come from.

The idea our team are investigating is to allow for *local conformal invariance* meaning that at each point we can make the transformation

$$g_{\mu\nu} \rightarrow \Omega^2(x)\, g_{\mu\nu},$$

so that our Pythagoras' Theorem equation can change in a special way (as above) without changing the mass-energy content implied by our new version of Eq. 3. A visualization is shown in Fig. 2. This idea is borrowed from quantum physics and indeed provides a much closer link to quantum physics and gravity, possibly even quantum gravity one day soon.

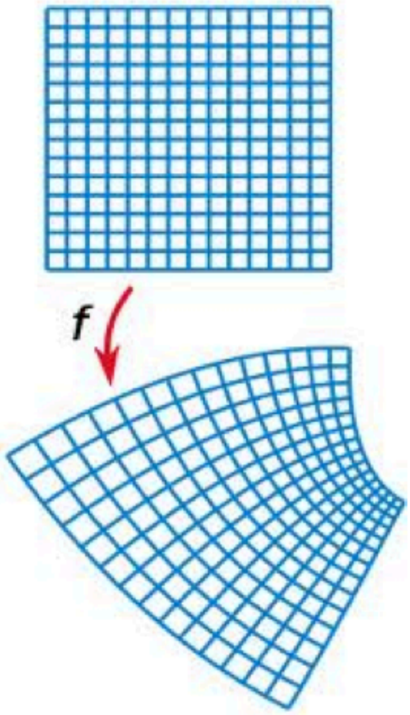

Fig 2. Conformal Visualization of a flat two dimensional geometry.

What about the problems of General Relativity? Well conformal gravity provides a consistent way of describing the Universe without the need of Dark Energy. Considering galaxies it can describe quite well the angular velocities of the stars contained therein, given a small amount of dark matter as would be expected given that a small amount of each galaxy does not emit electromagnetic radiation such as dead stars and small black holes.

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THE STANDARD MODEL