october 2008

canopus

monthly newsletter of the johannesburg centre of assa

Old Republic Observatory, 18a Gill Street, Observatory, Johannesburg

PO Box 412 323, Craighall, 2024

Globular Cluster NGC 6752 in Pavo. Photo by Lucas Ferreira on 3 September 2008 with an 8" Sky-Watcher Newtonian on EQ5 mount, F1200 (F/6). Camera used: Pentax K110D SLR for 90 second exposure at 800 ISO.

contents

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notice of next meeting – assa johannesburg

The next monthly meeting of the Johannesburg Centre of the Astronomical Society of Southern Africa will be held at the Johannesburg Planetarium, University of the Witwatersrand, Johannesburg on Wednesday, 8 October 2008 at 20h00:

Guest Speaker: Trevor Gould on

Meteorite Types and the South African Meteorite Database

assa johannesburg calendar

Date	Event	Details
4 October	Committee Meeting	Observatory @ 14:00
8 October	MONTHLY MEETING	Observatory @ 20:00 – Trevor Gould: "Meteorite Types"
13 October	SAIEE 2008 Bernard Price Memorial Lecture	Great Hall, Wits @ 18:30 - Prof. Sami K. Solanki: "Exploring our Fiery Star, the Sun"
8 November	Committee Meeting	Observatory @ 14:00
12 November	MONTHLY MEETING	Observatory @ 20:00 – Claire Lee: "Exploring the Universe through Particle Physics"

assa johannesburg committee members 2008/2009

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The Committee welcomes the following new members, and hopes that their membership of the ASSA Johannesburg Centre will prove to be interesting and enjoyable for them:

Mark Gidish (1118)
Chrysti Jo (1119)
Leonie Pybus (1120)
Alice Goodwin (1121)

editorial

by Claire A. Lee

Just in case you hadn't noticed, the world is still here.

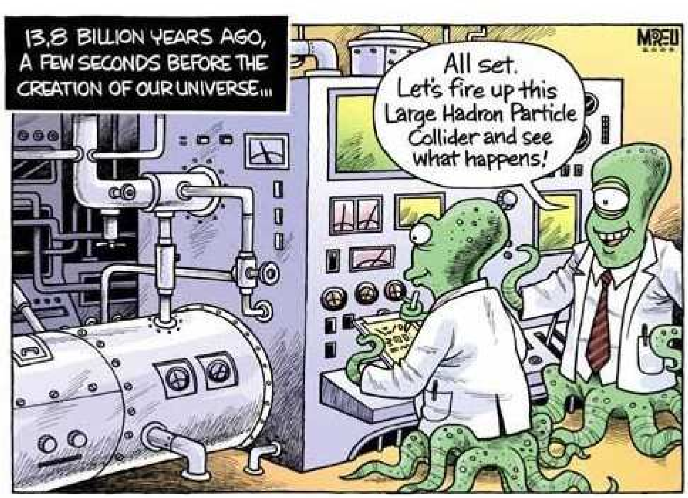
If you have no idea what I am talking about, consider yourself one of the lucky ones who hasn't been bombarded by questions about the LHC and what some feel is its alarming propensity to create black holes. In truth, for all practical purposes there is nothing to be worried about: the LHC is not going to create any black holes that will eat us all up.

I say "for all practical purposes" in the same context as "for all practical purposes there is no possibility of you walking through your wall and coming out the other side". Physics is *funny*, thanks to quantum mechanics there is an inherent uncertainty in the universe, leading there to be no such thing as zero probability. Which is where this whole mess came from. To be scientifically correct, any physicist you ask will say yes, there is *some miniscule* chance that black holes will be created. Just like there's *some miniscule* chance that you could walk through that wall. Though there is always the possibility that this has already happened and the black hole has gone off and hidden deep in the US economy. Hmmm…

Anyway, you have at least two more months to your arsenal before you need to worry again, as thanks to a large helium leak the LHC has been put out of action, meaning no collisions for a while. The stories are all over the news and the internet right now, though some think that the official CERN press release on the helium leak would have been better off given by someone with a high-pitched voice. Anyway, to celebrate this extra time we have with our planet intact, in this issue we have a list of 10 things you (may or may not) know about the earth, from the "Bad Astronomer" Phil Plait (www.badastronomy.com). Including a fantastic phonetic description of how to pronounce that pesky moon "Cruithne".

And of course there's part 2 of Sean Carroll's article on the arrow of time, where we hear about other universes and whether time could flow backward in them.

Finally, now that the nights are getting warmer there is no excuse for not getting out there and viewing Magda's object of the month, this time a glorious globular cluster in Pavo shown in the lovely photo on the cover. Can you get one too? Go have yourselves a great (black hole free) October! ■



chairman's chat

by Robert Groess

Firstly, a big thank you to Claire Flanagan and Constant Volschenk of the Johannesburg Planetarium, as well as Chris Middleton, for making our September monthly meeting something special. We try to have one meeting in the year a little different to the others, and had missed out on having a Planetarium meeting earlier in the year. Nonetheless, the wait was well worth it. The winter constellations were brought to life. We virtually visited the South Pole in three minutes flat. And didn't have to stay up all that late to see the summer constellations in the wee hours of the morning. The interactive nature of this experience made it all the more fun and after the show was over, some telescopes were set up outside so that people could put their new skill-set to the test.

It has been a while since we have organized a Star Party for our members. While the month of October is traditionally not that great weather-wise, the committee has decided to spin the roulette wheel and try for October 18, at the War Museum. Further details will be on our website as well as the email distribution lists. Our War Museum star parties typically draw crowds of about 50 people, coming from as far afield as Pretoria, and are always great fun due to the "mini-scopex" feel that they have with the added benefit of being situated centrally to boot.

Many of our new members may not know about the "metal planetary disks" which are situated behind the Sir Herbert Baker building on the very summit of the Observatory Hill, which are spaced apart in relative proportion to true mean planetary displacements. These metal obelisks have taken a pounding with the weather, and this prompted Oleg Toumilovitch to spearhead an initiative to give the planets a face-lift. Oleg has already sand-blasted the disks, as well as coated them with a primer. Thank you, Oleg! All that is left now to do is the fun bit and get the society/community involved in giving the planets their true colours. Further details will also be on our website and broadcast on the distribution lists.

That leaves me to round up for this month by saying that there is an ever increasing trend for our members to rely on electronic communications. Canopus has a significant turn-around time (typically 8 weeks) and serves a niche unto itself. For up-to-date information, please check in on our website regularly (www.assajhb.co.za) and it would be also beneficial to subscribe to the assajhb mailing list. For further details consult the website or feel free to ask any of our committee members.

With that I wish you another rewarding month of star-gazing!
Robert ■

exploring our fiery star, the sun

SAIEE 2008 Bernard Price Memorial Lecture

The Sun is a restless star. It shows a wide variety of transient or active phenomena, such as dark sunspots, the continuously changing hot corona, energetic flares and immense coronal mass ejections, together with the associated output of energetic radiation and particles. The variable solar output influences our natural environment, including global climate, and affects an increasing number and variety of technical systems in space and on Earth. In order to uncover the secrets of the Sun a whole armada of spacecraft is flying to different parts of the solar system, with the most exciting missions yet to come. Highlights of recent space missions, including some of the most spectacular movies recorded by them, are presented and plans for future missions are outlined.

Title: "Exploring our Fiery Star, the Sun"

Speaker: Prof. Sami K. Solanki

Date: Monday, 13 October 2008

Time: 18:30 for 19:00

Venue: Wits University Great Hall

Cost: FREE

Professor Dr. Sami K Solanki is a solar physicist and Managing Director of the Max Planck Institute for Solar System Research.

He did his PhD at the ETH in Zürich in 1987. He remained there until he took up office at the MPS. His scientific interest is focused mainly on the physics of the Sun, especially on solar magnetism and on the solar influence on the Earth, but also on stellar magnetism and on astronomical tests of gravitation theories.

He has published over 500 scientific papers, has contributed to space missions and is Principal Investigator of the SUNRISE Mission of DLR, NASA and the Spanish Space Agency. He is Editor in Chief of the electronic review journal "Living Reviews in Solar Physics" and spokesperson of the International Max Planck Research School on Physical Processes in the Solar System and Beyond. ■

10 things you don't know about the earth

by Phil Plait. *Original billiards images from Fictures. Cruithne animation from Wikipedia*

Look around you. Unless you're one of the Apollo astronauts, you've lived your entire life within a few hundred kilometers of the surface of the Earth. There's a whole planet beneath your feet, 6.6 sextillion tons of it, one *trillion* cubic kilometers of it. But how well do you know it?

Below are ten facts about the Earth — the second in my series of Ten Things You Don't Know *(Ed: we'll do the Milky Way next month).* Some things I already knew (and probably you do, too), some I had ideas about and had to do some research to check, and others I totally made up. Wait! No! Kidding. They're all real. But how many of them do *you* know? Be honest.

1) The Earth is smoother than a billiard ball.

Maybe you've heard this statement: if the Earth were shrunk down to the size of a billiard ball, it would actually be smoother than one. When I was in third grade, my teacher said basketball, but it's the same concept. But is it true? Let's see. Strap in, there's a wee bit of math (like, a really wee bit).

OK, first, how smooth is a billiard ball? According to the World Pool-Billiard Association, a pool ball is 2.25 inches in diameter, and has a tolerance of +/- 0.005 inches. In other words, it must have no pits or bumps more than 0.005 inches in height. That's pretty smooth. The ratio of the size of an allowable bump to the size of the ball is 0.005/2.25 = about 0.002.

The Earth has a diameter of about 12,735 kilometers (on average, see below for more on this). Using the smoothness ratio from above, the Earth would be an acceptable pool ball if it had no bumps (mountains) or pits (trenches) more than 12,735 km x 0.00222 = about 28 km in size. The highest point on Earth is the top of Mt. Everest, at 8.85 km. The deepest point on Earth is the Mariana Trench, at about 11 km deep. Hey, those are within the tolerances! So for once, an urban legend is correct. If you shrank the Earth down to the size of a billiard ball, it *would* be smoother. But would it be *round* enough to qualify?

2) The Earth is an oblate spheroid

The Earth is round! Despite common knowledge, people knew that the Earth was spherical thousands of years ago. Eratosthenes even calculated the circumference to very good accuracy! But it's not a perfect sphere. It spins, and because it spins, it bulges due to centrifugal force. That is an outwards-directed force, the same thing that makes you lean to the right when turning left in a car. Since the Earth spins, there is a force outward that is a maximum at the Earth's equator, making our Blue Marble bulge out, like a basketball with a guy sitting on it. This type of shape is called an *oblate spheroid*.

If you measure between the North and South poles, the Earth's diameter is 12,713.6 km. If you measure across the Equator it's 12,756.2 km, a difference of about 42.6 kilometers. Uh-oh! That's more than our tolerance for a billiard ball. So the Earth is *smooth* enough, but not *round* enough, to qualify as a billiard ball. Bummer. Of course, that's assuming the tolerance for being out-of-round for a billiard ball is the same as it is for pits and bumps. The WPA site doesn't say. I guess some things remain a mystery.

3) The Earth *isn't* an oblate spheroid.

But we're not done. The Earth is more complicated than an oblate spheroid. The Moon is out there too, and the Sun. They have gravity, and pull on us. The details are complicated, but gravity (in the form of tides) raises bulges in the Earth's surface as well. The tides from the Moon have an amplitude (height) of roughly a meter in the water, and maybe 30 cm in the solid Earth. The Sun is more massive than the Moon, but much farther away, and so its tides are only about half as high. This is much smaller than the distortion due to the Earth's spin, but it's still there.

Other forces are at work as well, including pressure caused by the weight of the continents, upheaval due to tectonic forces, and so on. The Earth is actually a bit of a lumpy mess, but if you were to say it's a sphere, you'd be pretty close. If you held the billiard-ball-sized Earth in your hand, I doubt you'd notice it isn't a perfect sphere. A professional pool player sure would though. I won't tell Allison Fisher if you won't.

4) OK, one more surfacey thing: the Earth is not exactly aligned with its geoid

If the Earth were infinitely elastic, then it would respond freely to all these different forces, and take on a weird, distorted shape called a *geoid*. For example, if the Earth's surface were completely deluged with water (give it a few decades) then the surface shape would be a geoid. But the continents are not infinitely ductile, so the Earth's surface is only approximately a geoid. It's pretty close, though.

Precise measurements of the Earth's surface are calibrated against this geoid, but the geoid itself is hard to measure. The best we can do right now is to model it using complicated mathematical functions. That's why ESA is launching a satellite called GOCE (Gravity field and steady-state Ocean Circulation Explorer) in the next few months, to directly determine the geoid's shape. Who knew just getting the shape of the Earth would be such a pain?

5) Jumping into a hole through the Earth is like orbiting it.

I grew up thinking that if you dug a hole through the Earth you'd wind up in China *(Ed: for us in Joburg, we'd end up somewhere near Hawaii)*. Turns out that's not true; in fact note that the US and China are both entirely in the Northern hemisphere which makes it impossible, so as a kid I guess I was pretty stupid. But what if you did dig a hole through the Earth and jump in? What would happen?

Well, you'd die (see below). But if you had some magic material coating the walls of your 13,000 km-deep well, you'd have quite a trip. You'd accelerate all the way down to the center, taking about 20 minutes to get there. Then, when you passed the center, you'd start falling up for another 20 minutes, slowing the whole way. You'd just reach the surface, then you'd fall again. Assuming you evacuated the air and compensated for Coriolis forces, you'd repeat the trip over and over again, much to your enjoyment and/or terror. Actually, this would go on forever, with you bouncing up and down. I hope you remember to pack a lunch.

Note that as you fell, you accelerate all the way down, but the acceleration itself would decrease as you fell: there is less mass between you and the center of the Earth as you head down, so the acceleration due to gravity decreases as you approach the center. However, the speed with which you pass the center is considerable: about 7.7 km/sec.

In fact, the math driving your motion is the same as for an orbiting object. It takes the same amount of time to fall all the way through the Earth and back as it does to orbit it, if your orbit were right at the Earth's surface (orbits slow down as the orbital radius increases). Gravity is bizarre. But there you go. And if you *do* go take the long jump, well, your trip may be a wee bit unpleasant.

6) The Earth's interior is hot due to impacts, shrinkage, sinkage, and radioactive decay.

A long time ago, you, me, and everything else on Earth was scattered in a disk around the Sun several billion kilometers across. Over time, this aggregated into tiny bodies called *planetesimals*, like dinky asteroids. These would smack together, and some would stick, forming a larger body. Eventually, this object got massive enough that its gravity actively drew in more bodies. As *these* impacted, they released their energy of motion (kinetic energy) as heat, and the young Earth became a molten ball. Ding! One source of heat.

As the gravity increased, its force tried to crush the Earth into a more compact ball. When you squeeze an object it heats up. Ding ding! The second heat source.

Since the Earth was mostly liquid, heavy stuff fell to the center and lighter stuff rose to the top. So the core of the Earth has lots of iron, nickel, osmium, and the like. As this stuff falls, heat is generated (ding ding ding!) because the potential energy is converted to kinetic energy, which in turn is converted to thermal energy due to friction.

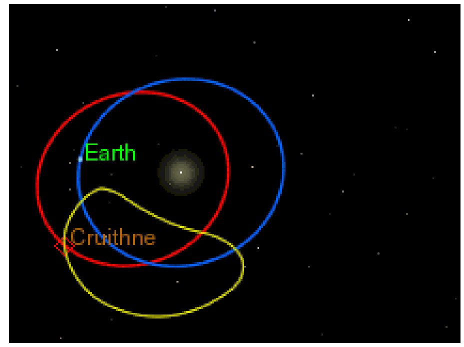
And hey, some of those heavy elements are radioactive, like uranium. As they decay, they release heat (ding ding ding ding!). This accounts for probably more than half of the heat inside the planet. So the Earth is hot in the inside due to at least four sources. But it's still hot after all this time because the crust is a decent insulator. It prevents the heat from escaping efficiently, so even after 4.55 billion years, the Earth's interior is still an unpleasantly warm place to be.

Incidentally, the amount of heat flowing out from the Earth's surface due to internal sources is about 45 trillion Watts. That's about three times the total global human energy consumption. If we could capture all that heat and convert it with 100% efficiency into electricity, it would literally power all of humanity. Too bad that's an insurmountable if.

7) The Earth has at least five natural moons. But not really.

Most people think the Earth has one natural moon, which is why we call it **the** Moon. These people are right. But there are four other objects - at least - that stick near the Earth in the solar system. They're not really moons, but they're cool.

The biggest is called Cruithne (pronounced MRPH-mmmph-glug, or something similar). It's about 5 kilometers across, and has an elliptical orbit that takes it inside and outside Earth's solar orbit.



The orbital period of Cruithne is about the same as the Earth's, and due to the peculiarities of orbits, this means it is always on the same side of the Sun we are. From our perspective, it makes a weird bean-shaped orbit, sometimes closer, sometimes farther from the Earth, but never really far away. That's why some people say it's a moon of the Earth. But it actually orbits the Sun, so it's not a moon of ours. Same goes for the other three objects discovered, too. Oh, these guys can't hit the Earth. Although they stick near us, more or less, their orbits don't physically cross ours. So we're safe. From them.

8) The Earth is getting more massive.

Sure, we're safe from Cruithne. But space is littered with detritus, and the Earth cuts a wide path (125 million square km in area, actually). As we plow through this material, we accumulate on average *20-40 tons* of it per day! Most of it is in the form of teeny dust particles which burn up in our atmosphere, what we call meteors. These eventually fall to the ground (generally transported by rain drops) and pile up. They probably mostly wash down streams and rivers and then go into the oceans.

40 tons per day may sound like a lot, but it's only 0.0000000000000000006% the mass of the Earth (in case I miscounted zeroes, that's 6×10^{-21} times the Earth's mass). It would take 450,000 trillion years to double the mass of the Earth this way, so again, you might want to pack a lunch. In a year, it's enough cosmic junk to fill a six-story office building, if that's a more palatable analogy.

I'll note the Earth is losing mass, too: the atmosphere is leaking away due to a number of different processes. But this is far slower than the rate of mass accumulation, so the net effect is a gain of mass.

9) Mt. Everest isn't the biggest mountain.

The height of a mountain may have an actual definition, but I think it's fair to say that it should be measured from the base to the apex. Mt. Everest stretches 8850 meters above sea level, but it has a head start due to the general uplift from the Himalayas. The Hawaiian volcano Mauna Kea is 10,314 meters from stem to stern (um, OK, bad word usage, but you get my point), so even though it only reaches to 4205 meters above sea level, it's a *bigger* mountain than Everest.

Plus, Mauna Kea has telescopes on top of it, so that makes it cooler.

10) Destroying the Earth is hard.

Considering I wrote a book about destroying the Earth a dozen different ways, it turns out the phrase "destroying the Earth" is a bit misleading. I *actually* write about wiping out life, which is easy. Physically destroying the Earth is hard.

What would it take to vaporize the planet? Let's define vaporization as blowing it up so hard that it disperses and cannot recollect due to gravity. How much energy would that take? Think of it this way: take a rock. Throw it up so hard it escapes from the Earth. That takes quite a bit of energy! Now do it again. And again. Lather, rinse, repeat… a quadrillion times, until the Earth is gone. That's a lot of energy! But we have one advantage: every rock we get rid of decreases the gravity of the Earth a little bit (because the mass of the Earth is smaller by the mass of the rock). As gravity decreases, it gets easier to remove rocks.

You can use math to calculate this; how much energy it takes to remove a rock and simultaneously account for the lowering of gravity. If you make some basic assumptions, it takes roughly 2×10^{32} Joules, or 200 million trillion trillion Joules. That's a *lot*. For comparison, that's the total amount of energy the Sun emits *in a week*. It's also about a trillion times the destructive energy yield of detonating every nuclear weapon on Earth.

If you want to vaporize the Earth by nuking it, you'd better have quite an arsenal, and time on your hands. If you blew up every nuclear weapon on the planet once every second, it would take 160,000 years to turn the Earth into a cloud of expanding gas! And this is only if you account for gravity! There are chemical bonds holding the Earth's matter together as well, so it takes even *more* energy. This is why Star Wars is not science fiction, it's fantasy. The Death Star wouldn't be able to have a weapon that powerful. The energy storage alone is a bit much, even for the power of the Dark Side.

Even giant collisions can't vaporize the planet. An object roughly the size of Mars impacted the Earth more than 4.5 billion years ago, and the ejected debris formed the Moon (the rest of the collider merged with the Earth). But the Earth wasn't vaporized. *Even smacking a whole planet into another one* doesn't destroy them! Of course, the collision melted the Earth all the way down to the core, so the damage is, um, considerable. But the Earth is still around.

The Sun will eventually become a red giant, and while it probably won't consume the Earth, it'll put the hurt on us for sure. But even then, total vaporization is unlikely (though Mercury is doomed). Planets tend to be sturdy. Good thing, too. We live on one. ■

does time run backward in other universes? – part 2

by Sean M. Carroll for *Scientific American*

The basic laws of physics work equally well forward or backward in time, yet we perceive time to move in one direction only - toward the future. Why?

To account for it, we have to delve into the prehistory of the universe, to a time before the big bang. Our universe may be part of a much larger multiverse, which as a whole is time-symmetric. Time may run backward in other universes.

At the end of part 1 in last month's Canopus, we read how inflation neatly explains the remarkably uniform density of matter in the universe. As an answer to the problem of time asymmetry however, inflation doesn't quite cut it, as it "explains a state of unusually low entropy by invoking a prior state of even lower entropy." Which left us with the following question: Why did inflation ever happen?

One of the reasons many cosmologists invoke inflation as an explanation of time asymmetry is that the initial configuration of dark energy does not seem all that unlikely. At the time of inflation, our observable universe was less than a centimeter across. Intuitively, such a tiny region does not have many microstates, so it is not so improbable for the universe to stumble by accident into the microstate corresponding to inflation.

Unfortunately, this intuition is misleading. The early universe, even if it is only a centimeter across, has exactly the same number of microstates as the entire observable universe does today. According the rules of quantum mechanics, the total number of microstates in a system never changes. (Entropy increases not because the number of microstates does but because the system naturally winds up in the most generic possible macrostate.) In fact, the early universe is the same physical system as the late universe. One evolves into the other, after all.

Among all the different ways the microstates of the universe can arrange themselves, only an incredibly tiny fraction correspond to a smooth configuration of ultradense dark energy packed into a tiny volume. The conditions necessary for inflation to begin are extremely specialized and therefore describe a very low entropy configuration. If you were to choose configurations of the universe randomly, you would be highly unlikely to hit on the right conditions to start inflation. Inflation does not, by itself, explain why the early universe has a low entropy; it simply assumes it from the start.

A Time-Symmetric Universe

Thus, inflation is of no help in explaining why the past is different from the future. One bold but simple strategy is just to say: perhaps the very far past is not different from the future after all. Perhaps the distant past, like the future, is actually a high-entropy state. If so, the hot, dense state we have been calling "the early universe" is actually not the true beginning of the universe but rather just a transitional state between stages of its history.

Some cosmologists imagine that the universe went through a "bounce." Before this event, space was contracting, but instead of simply crashing to a point of infinite density, new physical principles—quantum gravity, extra dimensions, string theory or other exotic phenomena—kicked in to save the day at the last minute, and the universe came out the other side into what we now perceive as the big bang. Though intriguing, bouncing cosmologies do not explain the arrow of time. Either entropy was increasing as the prior universe approached the crunch—in which case the arrow of time stretches infinitely far into the past—or the entropy was decreasing, in which case an unnatural low-entropy condition occurred in the middle of the universe's history (at the bounce). Either way, we have again passed the buck on the question of why the entropy near what we call the big bang was small.

Instead let us suppose that the universe started in a high-entropy state, which is its most natural state. A good candidate for such a state is empty space. Like any good high-entropy state, the tendency of empty space is to just sit there, unchanging. So the problem is: How do we get our current universe out of a desolate and quiescent spacetime? The secret might lie in the existence of dark energy.

In the presence of dark energy, empty space is not completely empty. Fluctuations of quantum fields give rise to a very low temperature—enormously lower than the temperature of today's universe but nonetheless not quite absolute zero. All quantum fields experience occasional thermal fluctuations in such a universe. That means it is not perfectly quiescent; if we wait long enough, individual particles and even substantial collections of particles will fluctuate into existence, only to once again disperse into the vacuum. (These are real particles, as opposed to the short-lived "virtual" particles that empty space contains even in the absence of dark energy.)

Among the things that can fluctuate into existence are small patches of ultradense dark energy. If conditions are just right, that patch can undergo inflation and pinch off to form a separate universe all its own—a baby universe. Our universe may be the offspring of some other universe.

Superficially, this scenario bears some resemblance to the standard account of inflation. There, too, we posit that a patch of ultradense dark energy arises by chance, igniting inflation. The difference is the nature of the starting conditions. In the standard account, the patch arose in a wildly fluctuating universe, in which the vast bulk of fluctuations produced nothing resembling inflation. It would seem to be much more likely for the universe to fluctuate straight into a hot big bang, bypassing the inflationary stage altogether. Indeed, as far as entropy is concerned, it would be even more likely for the universe to fluctuate straight into the configuration we see today, bypassing the past 14 billion years of cosmic evolution.

In our new scenario, the preexisting universe was never randomly fluctuating; it was in a very specific state: empty space. What this theory claims—and what remains to be proved—is that the most likely way to create universes like ours from such a preexisting state is to go through a period of inflation, rather than fluctuating there directly. Our universe, in other words, is a fluctuation but not a random one.

Emit fo Worra

This scenario, proposed in 2004 by Jennifer Chen of the University of Chicago and me, provides a provocative solution to the origin of time asymmetry in our observable universe: we see only a tiny patch of the big picture, and this larger arena is fully time-symmetric. Entropy can increase without limit through the creation of new baby universes.

Best of all, this story can be told backward and forward in time. Imagine that we start with empty space at some particular moment and watch it evolve into the future and into the past. (It goes both ways because we are not presuming a unidirectional arrow of time.) Baby universes fluctuate into existence in both directions of time, eventually emptying out and giving birth to babies of their own. On ultralarge scales, such a multiverse would look statistically symmetric with respect to time—both the past and the future would feature new universes fluctuating into life and proliferating without bound. Each of them would experience an arrow of time, but half would have an arrow that was reversed with respect to that in the others.

The idea of a universe with a backward arrow of time might seem alarming. If we met someone from such a universe, would they remember the future? Happily, there is no danger of such a rendezvous. In the scenario we are describing, the only places where time seems to run backward are enormously far back in our past - long before our big bang. In between is a broad expanse of universe in which time does not seem to run at all; almost no matter exists, and entropy does not evolve. Any beings who lived in one of these time-reversed regions would not be born old and die young - or anything else out of the ordinary. To them, time would flow in a completely conventional fashion. It is only when comparing their universe to ours that anything seems out of the ordinary—our past is their future, and vice versa. But such a comparison is purely hypothetical, as we cannot get there and they cannot come here.

As of right now, the jury is out on our model. Cosmologists have contemplated the idea of baby universes for many years, but we do not understand the birthing process. If quantum fluctuations could create new universes, they could also create many other things—for example, an entire galaxy. For a scenario like ours to explain the universe we see, it has to predict that most galaxies arise in the aftermath of big bang–like events and not as lonely fluctuations in an otherwise empty universe. If not, our universe would seem highly unnatural.

But the take-home lesson is not any particular scenario for the structure of spacetime on ultralarge scales. It is the idea that a striking feature of our observable cosmos—the arrow of time, arising from very low entropy conditions in the early universe—can provide us with clues about the nature of the unobservable universe.

As mentioned at the beginning of this article, it is nice to have a picture that fits the data, but cosmologists want more than that: we seek an understanding of the laws of nature and of our particular universe in which everything makes sense to us. We do not want to be reduced to accepting the strange features of our universe as brute facts. The dramatic time asymmetry of our observable cosmos seems to be offering us a clue to something deeper—a hint to the ultimate workings of space and time. Our task as physicists is to use this and other clues to put together a compelling picture.

If the observable universe were all that existed, it would be nearly impossible to account for the arrow of time in a natural way. But if the universe around us is a tiny piece of a much larger picture, new possibilities present themselves. We can conceive of our bit of universe as just one piece of the puzzle, part of the tendency of the larger system to increase its entropy without limit in the very far past and the very far future. To paraphrase physicist Edward Tryon, the big bang is easier to understand if it is not the beginning of everything but just one of those things that happens from time to time.

Other researchers are working on related ideas, as more and more cosmologists are taking seriously the problem posed by the arrow of time. It is easy enough to observe the arrow—all you have to do is mix a little milk into your coffee. While sipping it, you can contemplate how that simple act can be traced all the way back to the beginning of our observable universe and perhaps beyond. ■

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Questar Standard 3.5” telescope for sale. For more details please contact Tim Anderson on:

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Fax: 086 601 5592,
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focus on: A Grand Globular in Pavo

by Magda Streicher

Pavo the Peacock flies just south of Sagittarius in a rather curved trajectory easily traced amongst the southern stars. James Dunlop discovered NGC 6752 on July 28 1826 from Paramatta Observatory near Sydney. He first thought it to be two clusters on top of each other.

I always refer to NGC 6752 the globular cluster as brilliant, not only because it is easy to see, but because it contains all the elements one could wish for. This beautiful globular is only 13 000 light years away, and therefore contains some very bright stars in its mists. The beauty of it is that NGC 6752 can be seen with the naked eye if you're away from city lights. I tried my luck from the game park and succeeded with careful attention. A very faint hazy patch about 3 degrees NE from the 4-magnitude Lambda pavonis, NGC 6752 is also known as Bennett 121, Dunlop 295 and Caldwell 93.

With the 12” S/C telescope, NGC 6752 displays a brilliant large, bright oval glow in a NE-SW direction. Higher power reveals a well-resolved cluster with a small, bright and condensed core, slightly oblong. A close-up of the core shows faint stars spouting out to the north like a fountain. Pinpoint stars running out in trails and looping towards the edges remind me, in a way, of a cartwheel with its stars on the edge spraying out into the field of view. A brighter outstanding circle of stars is situated on the SE edge with a few doubles in formation. An eye-catching whitish 6.7-magnitude star can be seen embedded in the southern outskirts of the globular, while a few red stars can be glimpsed around the middle part of this globular cluster.

Our deepsky director Auke Slotegraaf has this to say about NGC 6752: “This cluster is best observed slowly, letting your eye play with the shapes that the stars seem to trace out across the face of this globular.” He describes the nucleus as banana-shaped.

My sincere thanks to Lucas Ferreira who will kindly provide me in future with excellent pictures to illustrate this article. And don’t you think this one is a master piece? (see cover photo).

Do not let the Peacock fly away with this sparkling jewel this spring without treating yourself to some long, lingering looks to absorb its glorious sights. ■

Name	Type	RA	DEC	Magnitude	Size
NGC: 6752	**Globular Cluster**	**19h10m.9**	**-59o59’**	**5.4**	**20.4’**

the sky this month

site location: lat. **26.0 deg S** long. **28.0 deg E** local time = UT **+2.0 hrs**.

october 2008

dd	hh			dd	hh		
1	01	Mars 5.0N of Moon		21	04	Pollux 4.7N of Moon	
1	23	Venus 4.8N of Moon		21	12	LAST QUARTER	
4	12	Antares 0.1N of Moon	Occn	22	18	Mercury greatest elong W(18)	
5	12	Moon at apogee		23	20	Regulus 1.7N of Moon	
6	21	Mercury inferior conjunction		25	05	Saturn 4.5N of Moon	
7	08	Jupiter 2.4N of Moon		26	23	Venus 3.1N of Antares	
7	10	FIRST QUARTER		28	00	Spica 2.6N of Moon	
10	10	Neptune 0.8S of Moon	Occn	28	23	NEW MOON	
12	13	Uranus 3.6S of Moon		29	23	Mars 4.9N of Moon	
14	21	FULL MOON		31	19	Antares 0.1S of Moon	Occn
15	06	Mercury stationary		31	21	Mercury 4.0N of Spica	
17	09	Moon at perigee					

november 2008

dd	hh			dd	hh		
1	08	Venus 2.6N of Moon		21	15	Saturn 5.0N of Moon	
2	07	Moon at apogee		24	07	Spica 2.8N of Moon	
2	08	Neptune stationary		25	18	Mercury superior conjunction	
3	23	Jupiter 2.0N of Moon		27	17	NEW MOON	
6	05	FIRST QUARTER		27	20	Mercury 3.7N of Moon	
6	19	Neptune 1.0S of Moon	Occn	27	22	Mars 4.1N of Moon	
8	22	Uranus 3.7S of Moon		28	00	Uranus stationary	
13	07	FULL MOON		28	01	Antares 0.1S of Moon	Occn
14	13	Moon at perigee		29	04	Mercury 0.6S of Mars	
17	11	Pollux 4.9N of Moon		29	14	Mercury 3.6N of Antares	
19	22	LAST QUARTER		29	20	Moon at apogee	
20	02	Regulus 2.0N of Moon		30	02	Mars 4.2N of Antares	

local times of rise and set for the sun & major planets

Date	Sun		Mercury		Venus		Mars		Jupiter		Saturn	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
Oct 07	05.31	18.13	05.23	18.12	06.58	20.47	06.20	19.38	10.46	1.16	04.27	15.54
Oct 17	05.17	18.21	04.40	17.00	06.56	21.08	06.00	19.32	10.11	0.40	03.55	15.24
Oct 27	05.05	18.30	04.28	17.03	06.58	21.30	05.41	19.27	09.38	0.06	03.18	14.49
Nov 06	04.55	18.40	04.28	17.38	07.04	21.49	05.23	19.22	09.06	23.32	02.41	14.14
Nov 16	04.47	18.50	04.32	18.20	07.16	22.04	05.07	19.17	08.34	22.59	02.04	13.39
Nov 26	04.42	19.00	04.41	19.01	07.32	22.15	04.52	19.13	08.04	22.27	01.26	13.03

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