# Pretoria Centre
Of the
Astronomical Society of Southern Africa

www.pretoria-astronomy.co.za

# NEWSLETTER FOR JANUARY 2004

## MEETINGS FOR JANUARY

The next meeting of the Pretoria Centre will take place at Christian Brothers College, Pretoria Road, Silverton, Pretoria, as follows:

**Date** : **Wednesday 28 January at 19:15 h**
**Chairperson** : **Michael Poll**
**Beginner's Corner** : **A modular dual mode grinding /polishing machine for large mirrors by Johann Swanepoel**
**What's Up** : **Johan Smit** **(continued on next page)**

**++++++++++++++++++BREAK (LIBRARY OPEN)+++++++++++++++**

**Main Topic** : **Structure of the cosmos by Jorrie Jordaan**

The meeting will be followed by tea/coffee and biscuits as usual.

**NEXT PRACTICAL**

The next social/practical evening will be held on Friday 23 January at the Centre Observatory, also at CBC. You can arrive anytime from 18:30 h onwards.

## ASTRONOMICAL WEBSITE ADDRESSES

(S & T = Sky and Telescope, a monthly popular astronomy magazine.)

New Horizons Pluto-Kuiper Belt Mission: http://pluto.jhuapl.edu
Article: S & T, November 2003, p. 30.

The Elegant Universe. A 3x1 hour TV Series recently shown on American TV (and hopefully on S A TV in the future.):
www.pbs.org/wgbh/nova/elegant
Article: S & T, November 2003, p. 70.

SETI: www.skypub.com/news/special/seti_toc.html

Meteorites:
International Meteorite Collectors Association:
www.meteoritecollectors.org
Natural History Museum's Meteorite Catalogue:
http://avalanche.nhm.ac.uk/cgi-bin/earth/metcat/
New England Meteoritical Services: www.meteorlab.com
Meteorite Magazine: www.meteor.co.nz
The Meteoritical Society: www.meteoriticalsociety.org

Pierre Lourens

## LIBRARY NEWS

We recently sorted all the periodicals in the library and there is a large number of duplicates of Sky and Telescope. As a result we have decided to offer these to our members at very reasonable rates. You can purchase duplicates as follows:
Single Issue R5.00 each
Complete volume of 6 issues R20.00 (must be a complete volume).
Please contact our librarian Janet Cooper if you wish to browse these issues and select those you want.

Tim Cooper

**THE FATE OF THE EARTH submitted by** Michael Poll

Life on Earth is three quarters of the way through its lifespan. Although the sun will not expand to become a red giant for another 7 billion years, its evolution will sterilize the Earth before then.
The sun is slowly growing brighter because of one way changes in its core. During its stable phase, gravity tries to collapse the sun, and compresses and heats the core so that hydrogen is converted ("burned") into helium, with the release of heat. The heat pressure counteracts the gravity, and the interior holds up against further collapse. The sun remains stable in this manner for several billion years.
However, during this time, as the proportion of helium "ash" increases, the core becomes more massive. Also, the helium does not burn, nor does it exert any extra outward gas pressure, so gravity then compresses the core. The core shrinks slightly and becomes denser and hotter. This causes the nuclear reactions which burn hydrogen to helium to speed up, with an increase in the amount of energy released. The rest of the sun expands slightly and the luminosity and amount of heat radiated increase. During the sun's long stable phase, these changes are imperceptible on a short time scale, but will manifest over million year periods, and as a result, the Earth warms slowly. This slow change has been going on since the sun began to shine - it is already 30% more luminous than it was shortly after it was formed 4.6 billion years ago - and the pace of the change will increase..
In 1982 James Lovelock and Michael Whitfield showed that as the Earth warms up, its surface rocks will weather faster and react more readily with the carbon dioxide ($CO_2$) in the atmosphere. Notwithstanding the $CO_2$ released by human activity, the atmospheric $CO_2$ will be removed, and become chemically bonded in sediments.
In 1992 Ken Caldeira and James F Kasting refined the earlier work, and estimated that in one billion years time, levels of $CO_2$ in the atmosphere would be too low to support photosynthesis, (which converts carbon dioxide into oxygen). Plants would vanish - a disaster for animals that eat them and breathe the oxygen that photosynthesis produces. However, the versatility of life's genetic material (DNA) could cope with the slow change of $CO_2$ levels during this time, and allow the evolution of new plants that require less carbon dioxide. Even on Earth

now there are some highly evolved plants that require one tenth the amount of $CO_2$ as normal plants.

However, after this one billion years, things change again. The sun will be 10% more luminous than it is now, and although it would seem that the decrease in $CO_2$ would allow the earth to stay cool in the face of a hotter sun, the extra solar heat will melt the polar ice caps, and warm up the oceans which will then evaporate on vast scales, causing an increase in water vapour in the atmosphere. Water vapour is a greenhouse gas in the same way that $CO_2$ is (it traps the suns heat, but does not allow it to escape), so oceanic evaporation would go even faster, leading to a runaway greenhouse effect. In 1½billion years time, the average surface temperature of the earth will be 50 deg C. Life may adapt to this temperature, or even up to the boiling point of water, considering that even now we see richer ecologies in the hotter parts of the earth where there is sufficient water, and we see life forms adapted to temperatures above 50 deg C. However the water may run out before boiling point is reached - in the upper atmosphere, sunlight breaks down water molecules into hydrogen and oxygen. The hydrogen escapes into space and does not return, so Earth's water is lost for ever.

In about 3 ½billion years from now, the sun will be 40% more luminous than at present. The Earth's water will have long vanished, and the surface will be bone dry, a similar situation to Venus today. With the evaporation of the water, the $CO_2$ that was dissolved in oceans (about 25 to 40% of the total $CO_2$), will have been released into the sky and will form the atmosphere, causing more greenhouse heating. This will soften the Earth's crust, causing an increase in volcanic activity and the release of even more $CO_2$ from rocks, and another runaway greenhouse event. The planet will be like an oven, totally devoid of water and with a thick $CO_2$ atmosphere. There will be no life.

About 7 billion years from now the next phase of solar evolution will start as the supply of hydrogen in the sun's core starts to run out. The core will not be able to hold up against gravity, and it will collapse, and heat up further causing the sun's energy output to increase further. The outer layers puff up to make the sun about 2 or 3 times its present diameter. The sun will be a sub- giant and will remain in this phase for about 700 million years. When all of the hydrogen in the core is exhausted, hydrogen burning takes place in a shell around the core. This speeds up hydrogen consumption and increases energy

production. The sun will swell up into a red giant, about 160 times it present diameter, engulfing Mercury and Venus. The fate of the Earth is not quite so clear. In the red giant phase the sun will lose about half of its mass (the escaped material forms a planetary nebula) before turning into a white dwarf. The mass loss weakens the suns gravity, so the planets move out into wider orbits. The Earth may move out far enough, perhaps to the orbit of Mars, and escape the suns expansion. Some theories predict that this will happen, but others suggest that the Earth will have already been engulfed before the final mass loss from the sun. The sun's luminosity will be about 2000 - 3000 times its current amount. If the Earth does survive, it will be a red hot lava ball, with a surface temperature of more than 1 500 deg C, and with its entire atmosphere and possibly its former crust, boiled away into space.

Reference: The Fate of the Earth by Mark A Garlick. Sky and Telescope, October 2002, page 30.

## RECENT NOTEWORTHY ARTICLES IN "SKY AND TELESCOPE"

A "pilgrimage" to historical places where important breakthroughs in astronomical knowledge were made to contribute to our modern world-view: S & T, November 2003, p.38.

"Cosmology in the new millennium": S & T, October 2003, p.32.

The future of computers in astronomy: S & T, September 2003, p. 60.

To subscribe to S & T, see the October 2003 newsletter or a recent issue of "Monthly Notes of the Astronomical Society of Southern Africa" (MNASSA) for details. I strongly recommend subscription. It is worth the money.

Pierre Lourens

# THE AGE OF THE UNIVERSE submitted by HARALD PAULER

1. The observable universe appears to be a sphere extending up to a radius of +-15 bill light years (L.Y.).
Q: Is that so because our present instruments can only cope up to that distance, and in time when we have more sophisticated instruments at our disposal we will see further, or is it because the extent of our present universe is only up to a radius of +- 15 bill L.Y. (edge of universe).

2. If the big bang occurred say 15 bill years ago, and assuming we are not in the centre of the universe, we should then be able to see much further in one direction than in the opposite. Since this does not happen, it should be proof that either the extent of the universe at present is not just +15 bill L.Y. in all directions but more, or that there was no big bang in the first case.

3. The following conundrum should prove one thing at least, if nothing else, that our universe is definitely not just 15 bill years old, but far older, if one can put a finite time scale to this anyway:

If objects are seen at +- 15 Bill L.Y. away (observable universe), how long did it take for these objects to travel there, let's call it primary position, from one point in space and time - Big Bang Theory.

See following calculations at various speed options:
1. Speed of light (not possible) 15 Bill years travel time, conclusion 15 Bill years to get there, plus 15 Bill years for light to get back - total of 30 Bill years ago.
2. Half the speed of light (highly unlikely) 30 Bill years travel time, conclusion 30 Bill years to get there, plus 15 Bill years for light to get back - total of 45 Bill years ago.
3. One quarter the speed of light (possible?) 60 Bill years travel time, conclusion 60 Bill years to get there, plus 15 Bill years for light to get back - total of 75 Bill years ago.
4. One eighth the speed of light ( possible?) 120 Bill years travel time, conclusion 120 Bill years to get there, plus 15 Bill years for light to get back - total of 135 Bill years ago.

If some objects have now travelled to this so-called primary position of +- 15 Bill L.Y. away, they are not going to stop there, but continuing with their journey further to a so-called secondary position of +- 30 Bill L.Y. away, at the following various speed options:

1a. Speed of light (not possible). 15 Bill years travel time plus 15 Bill years for light to get back, during which time presumably the objects travelled further (which light our present instruments have not picked up yet) – total presumable radius of universe 30 Bill L.Y.
2a. Half the speed of light (highly unlikely). 30 Bill years travel time plus 15 Bill years for light to get back, during which time presumably the objects travelled further (which light our present instruments have not picked up yet) – total presumable radius of universe 60 Bill L.Y.
3a. One quarter the speed of light. See point 3
4a. One eighth the speed of light. See point 4

Now, what's the age of the Universe?

If you want to communicate with Harald on this, you can contact him at:
tel: 012 335 0396  fax: 012 335 0397  e-mail: haraldp@absamail.co.za
Editor

## SKY GUIDE AFRICA SOUTH

The old annual publication “Astronomical Handbook for Southern Africa” now has the above title. It is in a new, neater format and contains more information than the issues of previous years. If you become a member of ASSA (The Astronomical Society of Southern Africa), you receive this guide at the beginning of every year. You can also order it from ASSA. For more information, go to the ASSA website at: http://www.saao.ac.za/assa/ Click on “publications”, then on “sky guide”. Copies of the guide for 2004 will also be offered for sale @ R40 each at the meeting on 28 January. If you are an observer, you definitely should have one.

Pierre Lourens

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