ORIGIN OF SUPERHEAVY ELEMENTS: A CLUE TO THE EXISTENCE OF BLACK HOLES ?

The recent discovery by a team of U. S. physicists of the superheavy elements with Z=116, 124 and 126 (R. V. Gentry et al. 1976, *Phys. Rev.* Letts. **37**, 11) has been received with a great surprise and this has given rise to speculations in physical (P. Hodgson 1976, *Nature*, **261**, 627; R. Walgate, 1976, *New Sci.*, **70**, 696) and astrophysical (J. E. Pringle et al. 1976, *Nature*, **263**, 114; G.L. Murphy, 1976, *Nature*, **263**, 114) circles alike. These elements detected in the mineral monazite from Madagascar, are of natural origin and have been found in large quantities.

Where could the superheavies come from ? The elements are unlikely to have been produced in the big bang or by the r - process. According to Pringle et al. and Murphy, formation or disruption of neutron stars provides an ideal arena for the production of superheavies because it ensures large supply of neutrons and fast β decay. The surface of a newly formed neutron star remains fluid for a short while after the collapse of the supernova core, even though it cools soon afterwards below the crystalline melting point by way of neutrino emission. During oscillations following the collapse, the surface may have a considerably larger density than the equilibrium value of perhaps 10^{11} gm cm^{-3}. The evaporation of superheavy elements from the surface of such a newly formed neutron star might take place simultaneously with the processing of heavy elements by neutron capture in the supernova explosion itself. Alternatively, the superheavies which might exist in the outer layers of neutron stars, might by its disruption also escape to infinity. The disruption may be caused either by its tidal interaction with a black hole so that some of the stellar material can be ejected to infinity or by sufficient accretion (which would change the surface composition considerably) such that the mass becomes larger than the critical mass limit when it should collapse to become a black hole and shed some of its outer layers into interstellar medium.

The processing of such superheavies in astrophysical situations calls for special conditions which presently seem to be met only in neutron stars. However, black hole-neutron star encounters have to be very close or sufficient amount of material should be available for accretion on to the neutron star. Therefore, binary systems with one of the components as neutron stars would be the best kitchens for the cooking of superheavy elements. It would not be out of place to suggest that the other component too may evolve to produce a collapsed star and contribute further to superheavies.

The binary X-ray sources, e.g. Her X-1 and Cen X-3 do suggest the existence of accreting neutron stars. And if superheavies are produced in the disruption of neutron stars then the existence of superheavy elements could possibly be taken to imply the existence of black holes too.

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MARS : ACTIVE METEOROLOGY BUT NO LIFE

Viking I & II landed on Mars on July 20th and September 4th 1976 and have sent detailed observations on chemical, meteorological, geomorphological and biological aspects of the planet and its atmosphere. In all there were fourteen experiments on each of these missions. These included thermal imaging of Planetary surface, study of atmospheric constituents by gas chromatograph mass spectrometer, chemical analysis of soil by x-ray fluorescence spectrometer, gas pyrolytic experiment with radiocarbon for biological activity in the soil, radioactive labelled gas release experiement and gas exchange under controlled condition for search of life constituents on Mars in addition to photography by the orbiter and the lander.

The main results of these experiments are as follows: (*Science*, 1976; **193**, 759–815; **194**, 57-105). The martian atmosphere consists of 95% carbondioxide as expected but nitrogen, oxygen and carbon-mono-oxide were also present. These gases occur at about 6%, 0.3% (by volume) and trace levels. The presence of nitrogen was not anticipated and encouraged hopes of finding biological constituents on the planet. Argon was only about 1.5%, much less than expected. If the Planet had completely degassed, one would expect about 30% Argon and therefore this observation has important bearing on the thermal history of the planet. One conclusion straight away follows that Mars has been thermally much less active than the earth. A search for other rare gases like Ne, Kr, Xe lead us to upper limits of 10, 20 & 50 ppm supporting this conclusion. Isotopic analysis of argon gave $Ar^{36} : Ar^{40} = 1 : 2750\ (\pm 500)$, about ten times lower than the earth's whereas isotopic abundances of $C^{12} : C^{13}$ and $O^{16} : O^{18}$ is similar to the terrestrial values. The pressure at the landing site was only 7 millibars or 0.007 of the earths atmosphere.

In spite of the tenuous atmosphere the martian climate is extremely variable. Several dust storms had been observed earlier and seasonal changes are expected to be extreme. Chryse Planitia appears to be a boulder strewn deep reddish desert with distant eminences formed by wind-blown sand dunes, mounds and rims of impact craters. The rocks are highly pitted, vesicular and show strong signs of wind scouring. Thus both impact as well as aeolian and fluvial processes are responsible for shaping the surface features of Mars. Diffuse morning hazes and white clouds are distinctly visible in the pinkish martian sky. The water vapour content of Mars is meagre - about 3 precipitable micrometers with a gradual increase across the equator to northern latitudes. It is likely that huge amounts of water lay frozen below the solid carbon-di-oxide polar caps, which may be released partly during summer. A diurnal cycle between solid and vapour phases as well as in temperature was observed. The diurnal temperature fluctuation ranged between 260°K to 185°K with areas in south polar nights at 134°K much below CO_2 condensation point. Wind speeds upto 9 m per second were observed with a remarkable regularity in directions; gravitational oscillations or tidal effects of diurnal pressure wave probably plays an important role. The composition of the martian

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anisotropy in source distributions, some suggestions of anisotropy in source counts were presented, especially between the Northern and Southern Galactic Hemispheres for the 5 GHz Parkes and NRAO surveys. No general consensus emerged as to whether the anisotropy was real or due to some observational selection. A discussion initiated by Kellermann on whether the source count data required the deduction that the Universe is evolving brought out some of the controversies of interpretation.

Extensive data on spectral index distributions and angular sizes of radio sources was presented, including the recent work of Swarup and Kapahi based on the Ooty and 3CR surveys. The Cambridge data presented by Riley showed that high luminosity quasars do not show size evolution. Narlikar and Roeder respectively presented statistical and theoretical reasons to show that the angular size flux density relation is not yet capable of arriving at a clear cosmological conclusion. Roeder pointed out the uncertainty of interpretation arising from the inhomogeneity of the intergalactic medium. The determination of redshifts exceeding 0.45 up to about 0.7 for about 10 radio galaxies, have become possible due to the recent availability of stable high quantum efficiency detectors which allow subtraction of the sky noise.

Kristian, Hazard and others presented the details of latest efforts in the optical identification of radio sources and quasars. Fanti and Perola discussed the radio luminosity functions. Physical conditions in quasars and radio galaxies were discussed in detail by Osterbrock. Boksenberg discussed absorption line redshifts in large redshift quasars. The controversial topic of whether absorption line systems are intrinsic or due to intervening galaxies gave rise to a lot of discussion. Of considerable controversy because of its implications, was the identification of the radio source 3C 303 with a quasar-galaxy system with anomalous redshifts. Those who do not like anomalous redshifts argued in favour of a possible mis-identification. Margaret Burbidge was among those who thought that the case for identification was a good one.

The evolutionary aspect of the radio sources was presented in various forms by Maarten Schmidt, Malcolm Longair (who also presented work of the absent Russians Sunyaev and Novikov), John Bahcall, Peter Scheuer, Julia Riley etc. Against this avalanche of the evolutionary theology the lone agnostic voice was raised by Geoffrey Burbidge who argued that the radio source data in its present form did not really warrant the conclusion that the universe is evolving.

The microwave background measurements were reviewed by Robson who pointed out the difficulties in millimetre measurements which would really establish the crucial fact whether the background is of blackbody character. Measurements to date indicate a turnover as required by the blackbody curve but further work is necessary to establish the Planckian character.

A light relief after an exhausting and controversial discussion of the present data was provided by Bill Saslaw who discussed possible short-term (1–2 years), middle-term (10–30 years) and long-term ($\sim$ century or more) observations of cosmological significance. Of the last type was one in which we wait to be discovered by superior extraterrestrials, and then ask them what the universe is really like!

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soil determined by the x-ray spectrometer suggests 15% iron, 15% silicon, 5% calcium, 5% aluminium and about 1% titanium. There are also indications of small amounts of sulfur and chlorine. The red colour of the planet is attributed to a thin coating of the red oxide of iron - limnolite.

Biologically the results for search of living organisms or organic constituents of life have been negative. It is hard to distinguish chemical activity from biological activity by preplanned experiments but, apart from a few results which are not understood completely, there seems to be no indication for life bearing organisms in the martian soil.

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