

## 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  $\beta$  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  $\text{cm}^{-3}$ . 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 experiment 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  $\text{Ar}^{36} : \text{Ar}^{40} = 1 : 2750$  ( $\pm 500$ ), about ten times lower than the earth's whereas isotopic abundances of  $\text{C}^{12} : \text{C}^{13}$  and  $\text{O}^{16} : \text{O}^{18}$  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  $\text{CO}_2$  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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