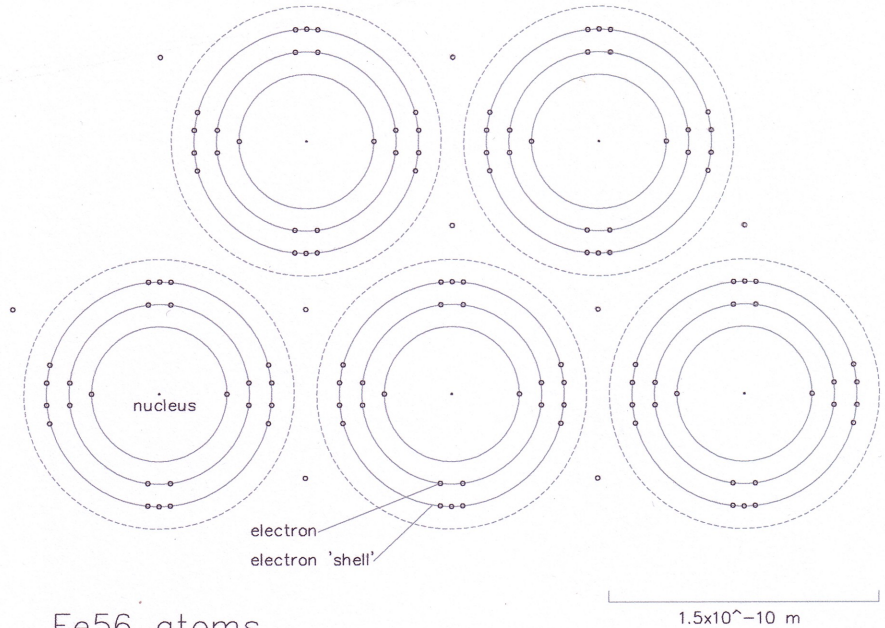


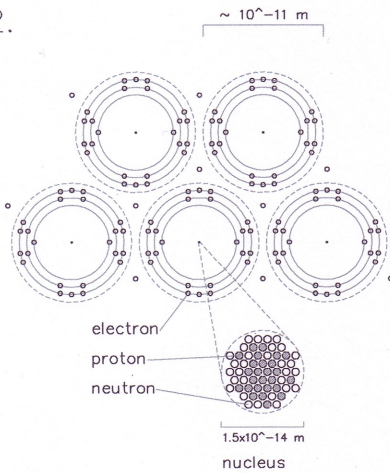
PHASES OF MATTER IN A NEUTRON, PROTON, HYPERON, QUARK STAR

1.



Fe56 atoms

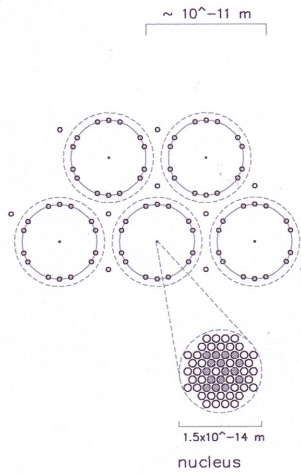
2.



Electron degenerate Fe56 atoms

$1 - 4 \times 10^4 \text{ tonne/cm}^3$

3.

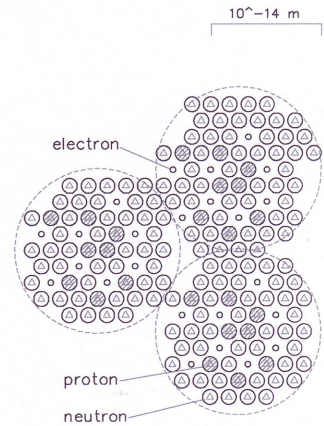


Electron capture takes place (inverse beta decay) forming neutron rich electron degenerate atoms.

$4 \times 10^4 - 0.2 \times 10^9 \text{ tonne/cm}^3$

NEUTRON D E G E N E R A T E D

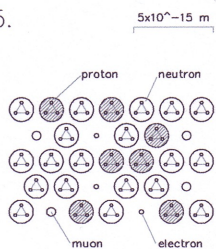
4.



Atoms collapse, nuclei combine to form neutron degenerate matter with some protons and electrons (and muons).

$0.2 \times 10^9 - 0.8 \times 10^9 \text{ tonne/cm}^3$

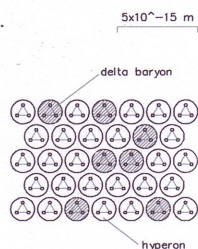
5.



Neutron degenerate matter with some protons and electrons (and muons).

$0.2 \times 10^9 - 0.8 \times 10^9 \text{ tonne/cm}^3$

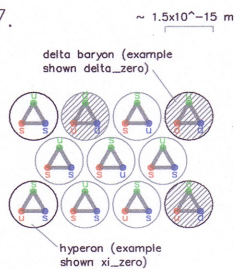
6.



Hyperons (combination of up, down and strange quarks) and delta baryons (combination of neutrons or protons with pions).

Hyperon types—
lambda_zero, sigma_minus, sigma_plus, sigma_zero, xi_zero, xi_minus.
Delta baryon types—
delta_plus-plus, delta_plus, delta_zero, delta_minus.
 $0.8 \times 10^9 - 2 \times 10^9 \text{ tonne/cm}^3$

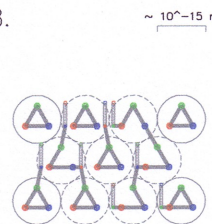
7.



Hyperons and delta baryons in close proximity

Examples shown—
-Xi_zero hyperon = 2x strange quarks, 1x up quark ($2 \times -1/3 + 1 \times +2/3 = 0$ charge).
-Delta_zero baryon (proton plus pion_minus) = 2x up quarks, 1x down quark plus 1x down quark, 1x antiup quark ($2 \times 2/3 + 1 \times -1/3 + 1 \times -1/3 + -2/3 = 0$ charge).
 $0.8 \times 10^9 - 2 \times 10^9 \text{ tonne/cm}^3$

8.

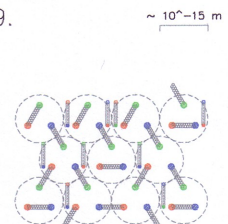


Quark-gluon plasma.

Gluons composed of colour charge in colour-anticolour pairs.

Examples—
blue-antired, red-antiblue, green-antired.
 $> 2 \times 10^9 \text{ tonne/cm}^3$

9.



Colour superconductive quark matter (free gluons).

quarks form pairs, gluons begin to behave like vector mesons.

$> 2 \times 10^9 \text{ tonne/cm}^3$