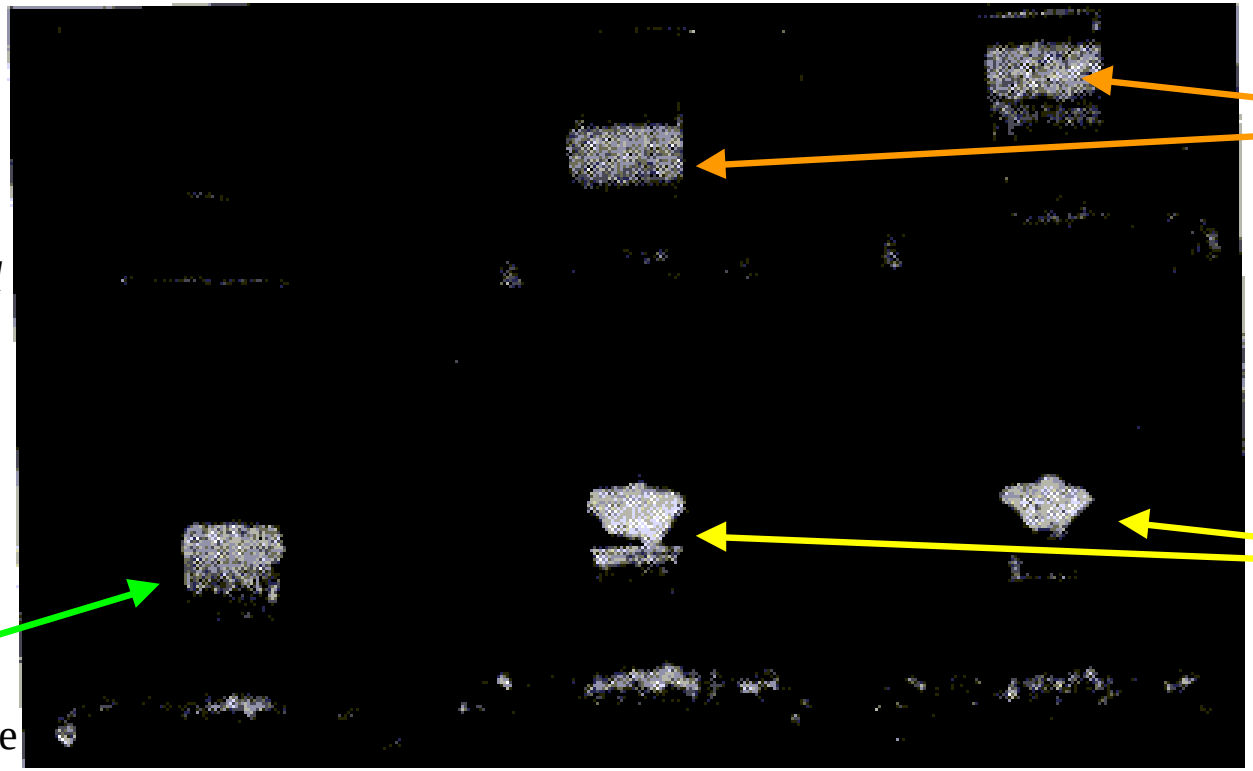
MetaStable Helium and Metamatter

Time-lapse photograph from Melvin Cook's, "Cohesion in Plasma," *Journal of Applied Physics*, Vol. 29, p. 1612, Nov. 1958.

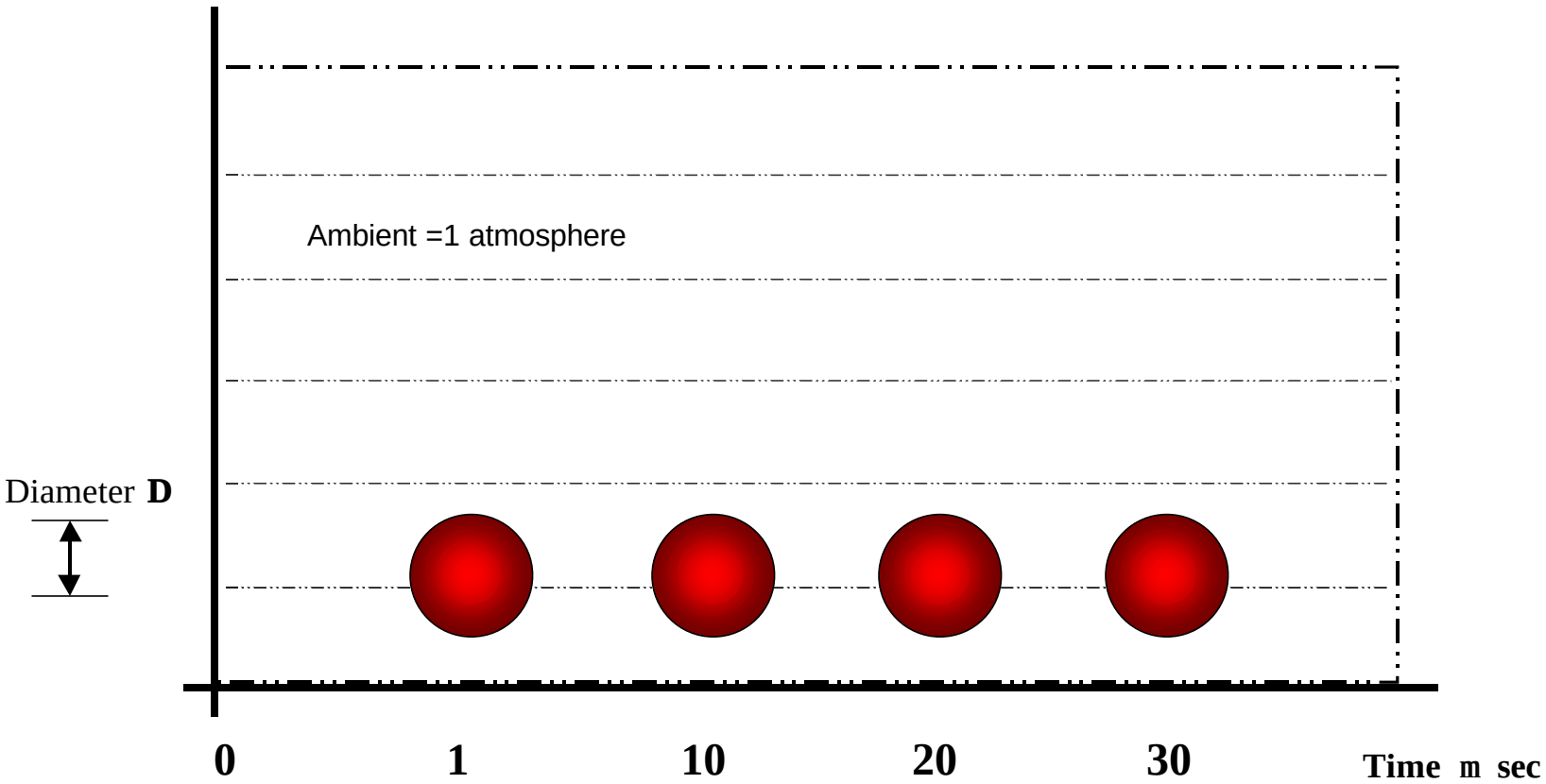


by Robert W. Bass, BAE SYSTEMS

LMP

Liquid Metallic Plasmoid

Nitro-Nobel Medalist, **Melvin Cook** (Cover, *Journal of Applied Physics*, Nov. **1958**)



Measured Diameter **D** does **not** increase in time!

Accidental experimental discovery of self-cohesion in a dense plasma

Ideal Plasma Equation of State

Interparticle distance $d \ll D$ = Debye shielding length

$\boldsymbol{p}$ = pressure (joules/m^3)

$\boldsymbol{n}$ = particle density (per m^3)

$\boldsymbol{k}$ = Boltzmann's constant (joules/kelvin)

$$\boldsymbol{p = 2nkT}$$

Plasma Equation of State (Berlin-Montroll)

$\boldsymbol{p}$ = pressure (joules/m^3)

$\boldsymbol{n}$ = particle density (per m^3)

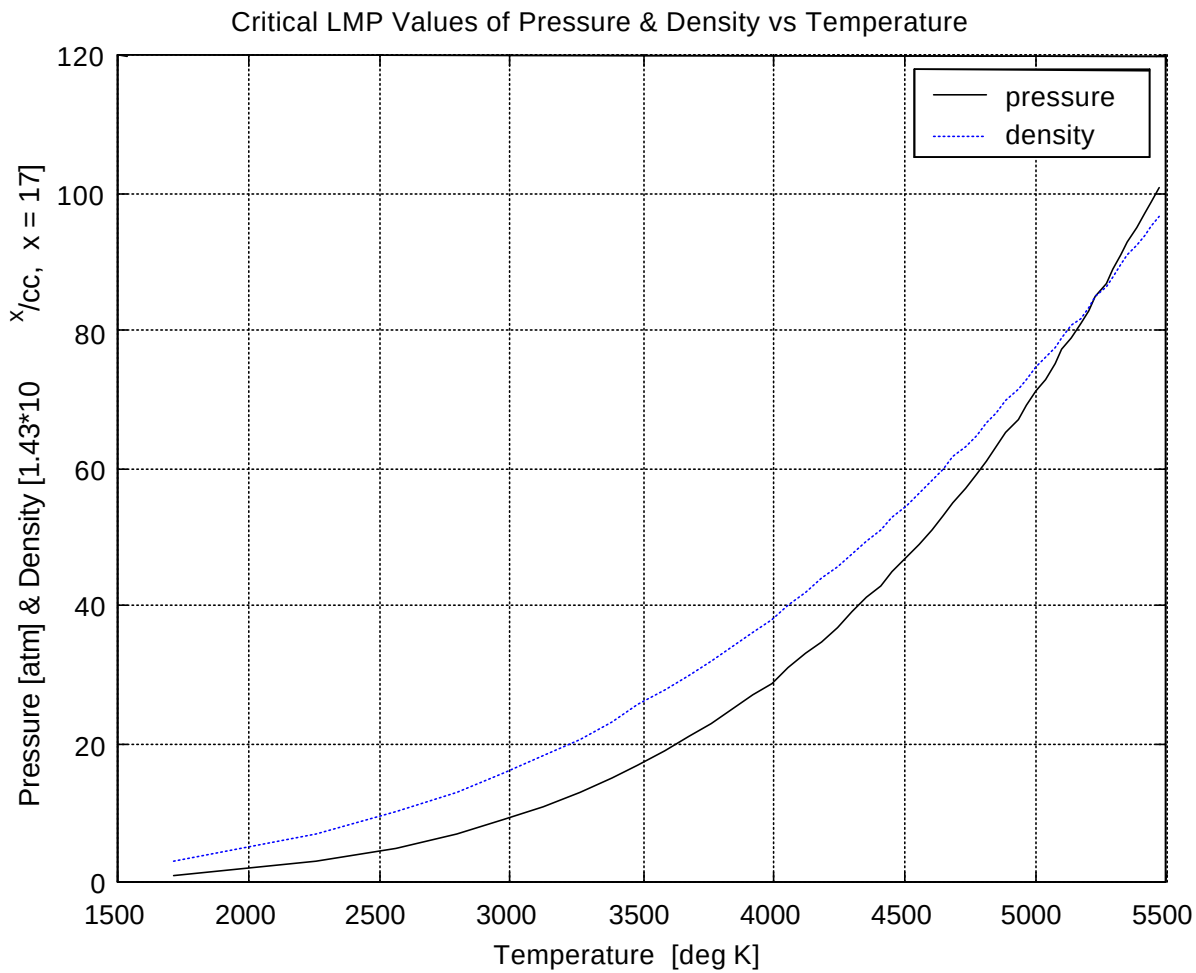
$\boldsymbol{k}$ = Boltzmann's constant (joules/kelvin)

$\boldsymbol{e}$ = electron charge (Coulombs [= { joule-m }$^{1/2}$])

$$\boldsymbol{p} = \{ (7/6) - [(2\mathrm{p})^{1/2} \cdot (\boldsymbol{e}^2/2)] \cdot (\boldsymbol{n}^{1/3} / \boldsymbol{kT}) \} \cdot 2\boldsymbol{nkT}$$

implies

$$\boldsymbol{p} < 0 \quad \text{if} \quad \boldsymbol{n} >> (\boldsymbol{kT})^3$$

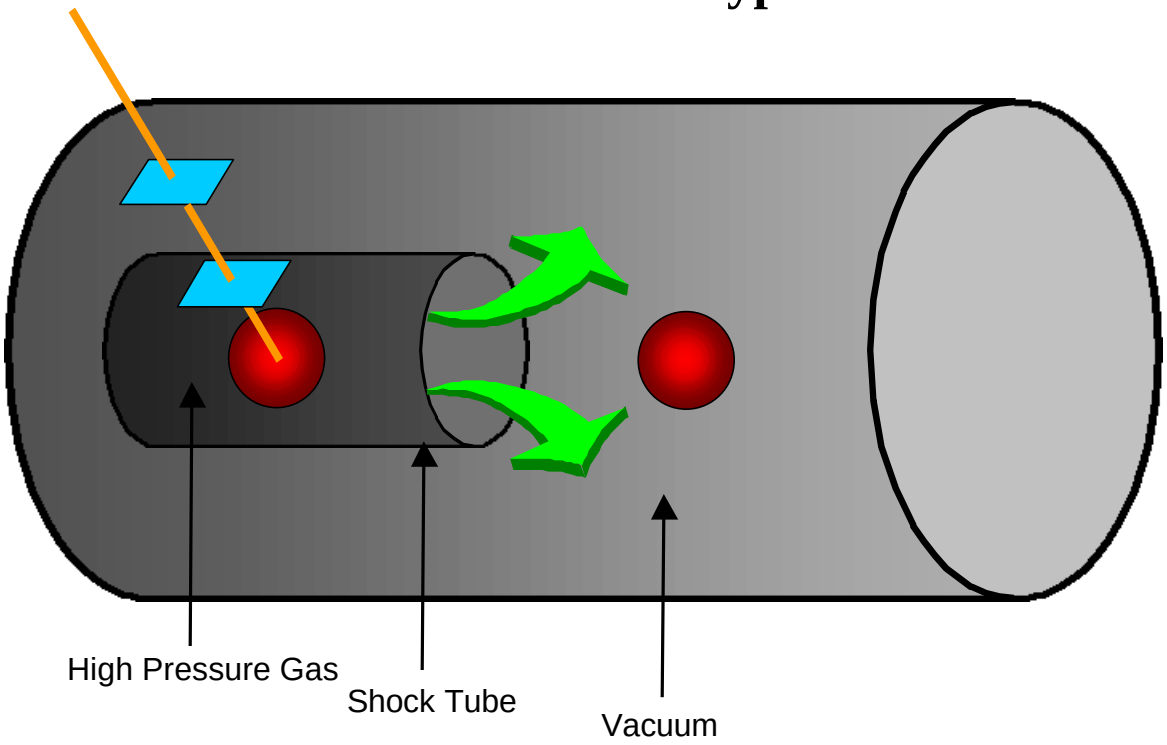


Brush-Sahlin-Teller Equation of State

LMP

Proof -of -Principle

Process Prototype



LMP= Liquid-Metallic Plasmoid

cooled LMP (He) =Metastable Helium=MSH

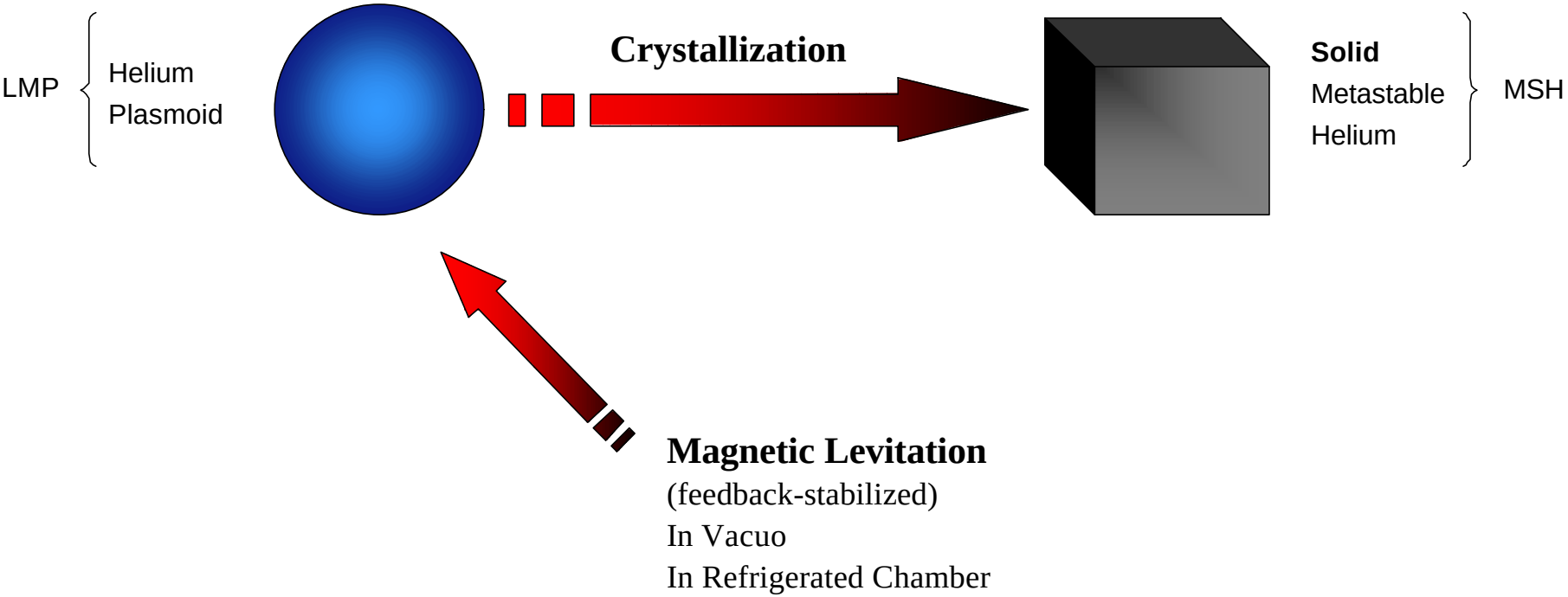
cooled LMP (D)=Metastable Deuterium=MSD

cooled LMP (H)=Metastable Protium=MSP

} Solid Crystals

MSH

Metastable Helium Manufacturing Process



LMP → MSH

Ideal
Rocket
Propellant

(He = $^{4}_{2}\mathrm{He}$**)**

Metastable Helium

LMP → MSP

Ideal
Room Temperature
Superconductor

(P = $^{1}_{1}\mathrm{H}$**)**

Metastable Protium

LMP → MSD

Ideal
Fusion
Fuel

(D = $^{2}_{1}\mathrm{H}$**)**

Metastable Deuterium

Three species of **Metamatter** which address different markets