BAE SYSTEMS

GRADUATE LECTURE

Warton, 26th March 2003.

Stanmore, 9th April 2003.

Project GREENGLOW

(Unclassified)

Dr. Ron. Evans
Technologist
R&T Advanced Technology Demonstration Centre
Hangar W31

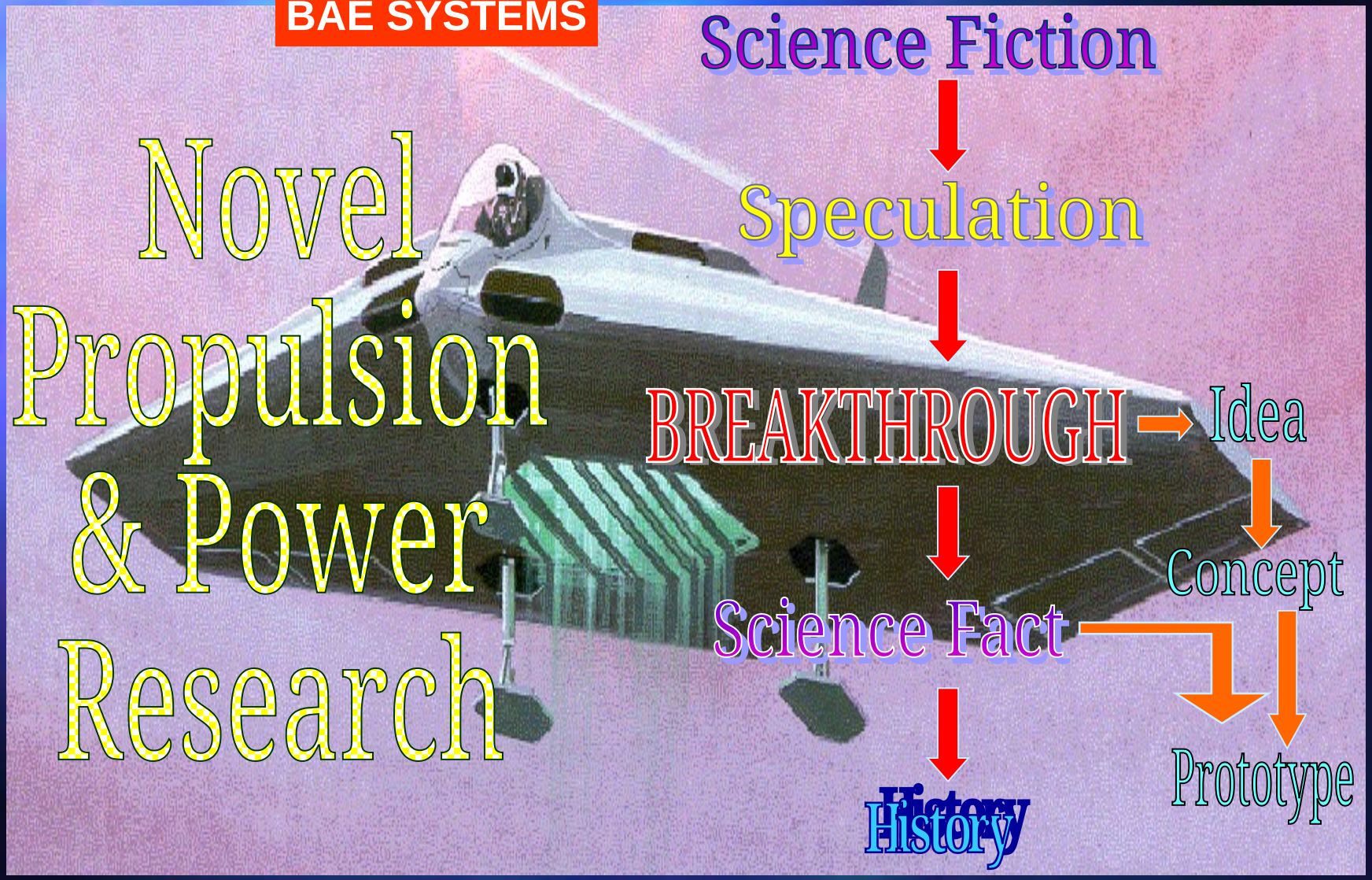
Right at the Start

GREENGLOW

PROGRAMME:	**Small speculative research Studies.**
PURPOSE:	**To provide Focus for Ideas. To avoid Surprises.**
INITIATION:	**By the Technologists.**
CREDIBILITY:	**Must be seen to be managed Professionally.**
RESEARCH:	**Done at Universities.**
EXPERTS:	**The Academics.**
MY ROLE:	**Co-ordination, Direction & Information Channel.**
FUNDING:	**ATC + R&T.**
NEW BUSINESS:	**Not in our remit. But we should draw attention.**

GREENGLOW

BAE SYSTEMS



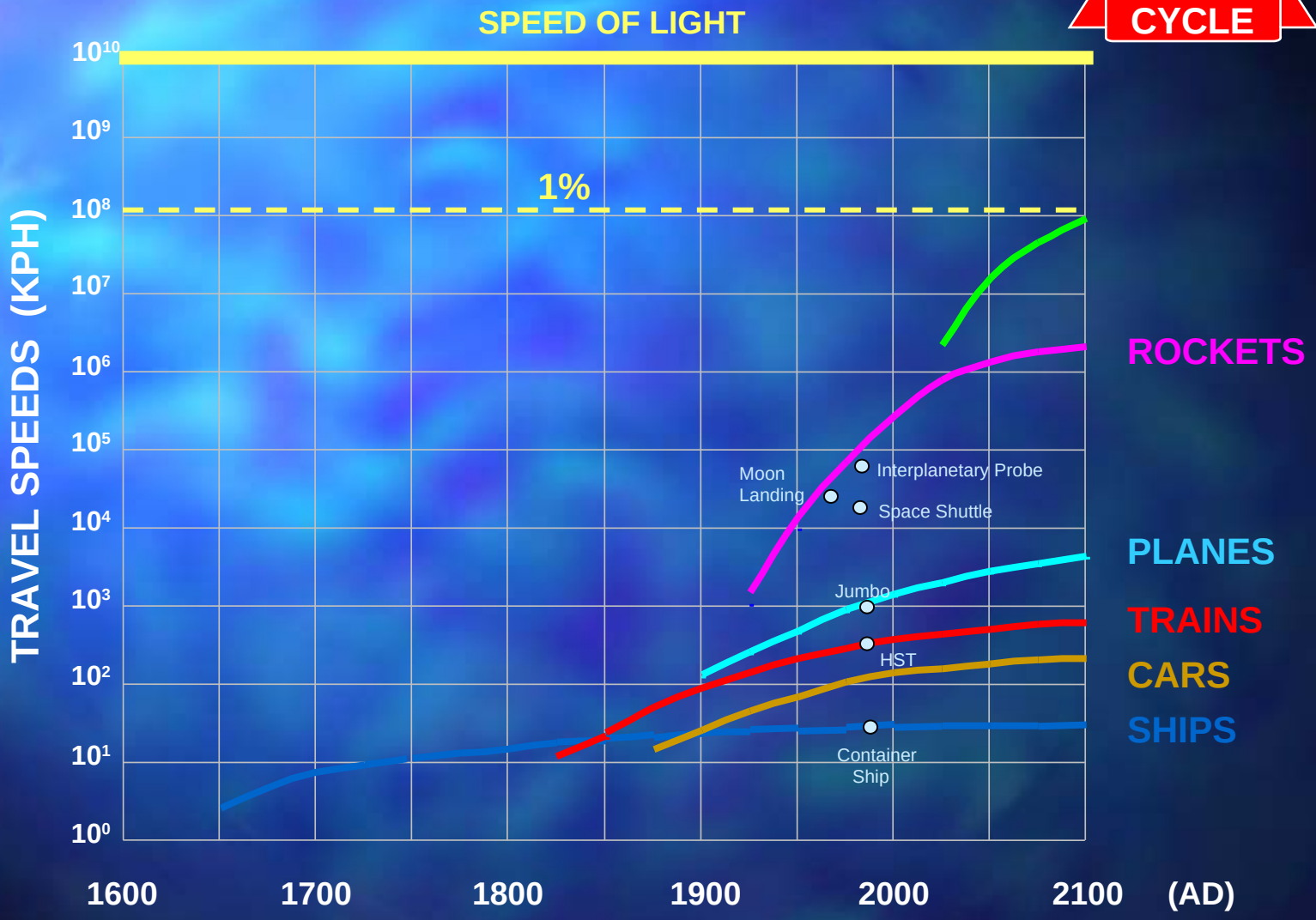
Evolution of Technology

(Adapted from *NASA BPPP*)

After the BREAKTHROUGH

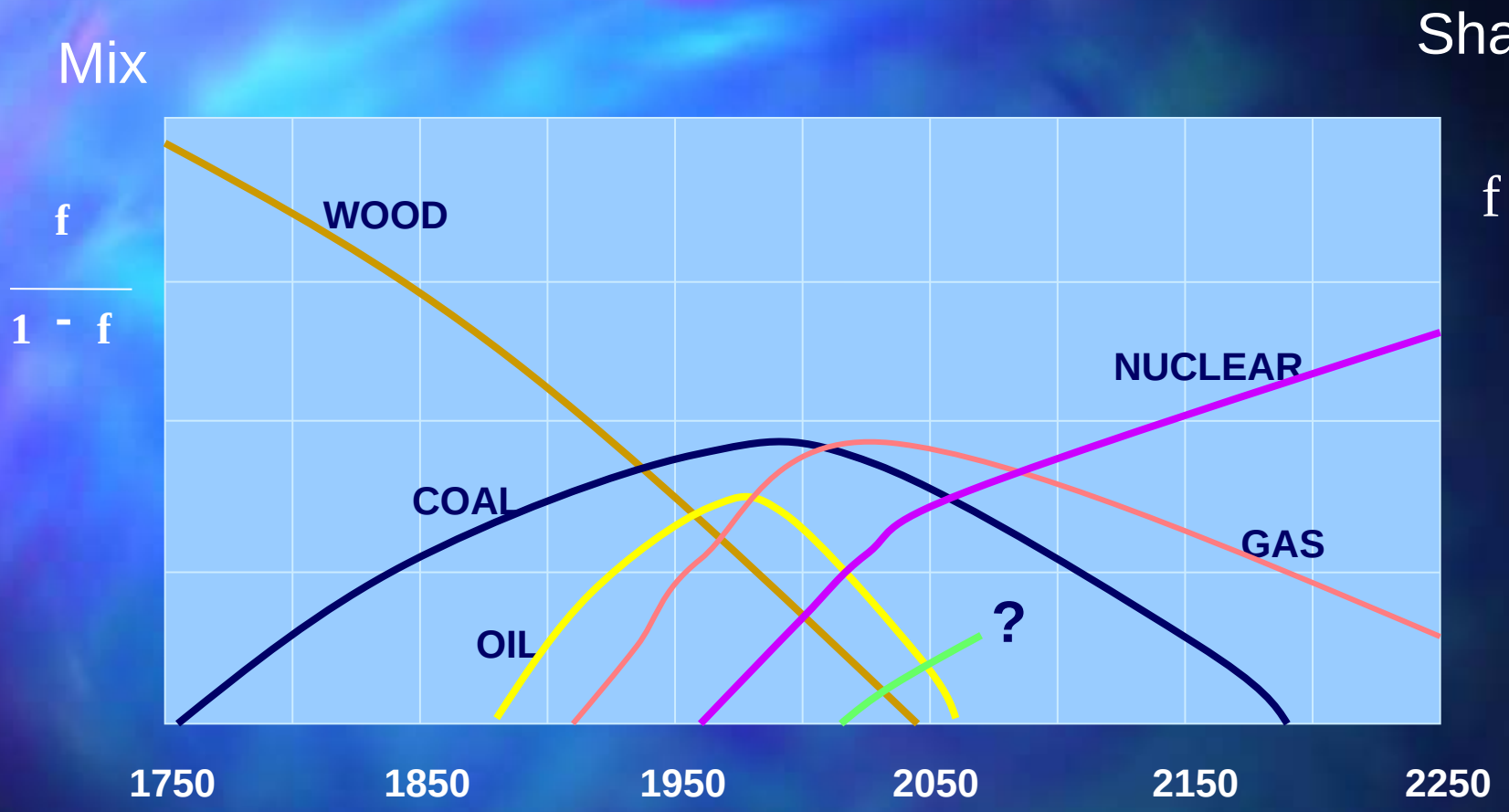
KONDRATIEFF

55 Year CYCLE



(Adapted from Strong's "Flight to the Stars", 1953)

A new source of Energy ?



Historical Life Cycles of Primary Energy Sources.

(Based on Marchetti)

BREAKTHROUGH DIRECTED RESEARCH

NASA
Breakthrough - in - Propulsion - Physics

Start: 1996
(USAF 'Electric Propulsion Study 1991)

Goals:

1. **Propulsion without expelling mass.**
2. **Increasing Maximum Transit Speed.**
3. **New Energy Source to power devices.**

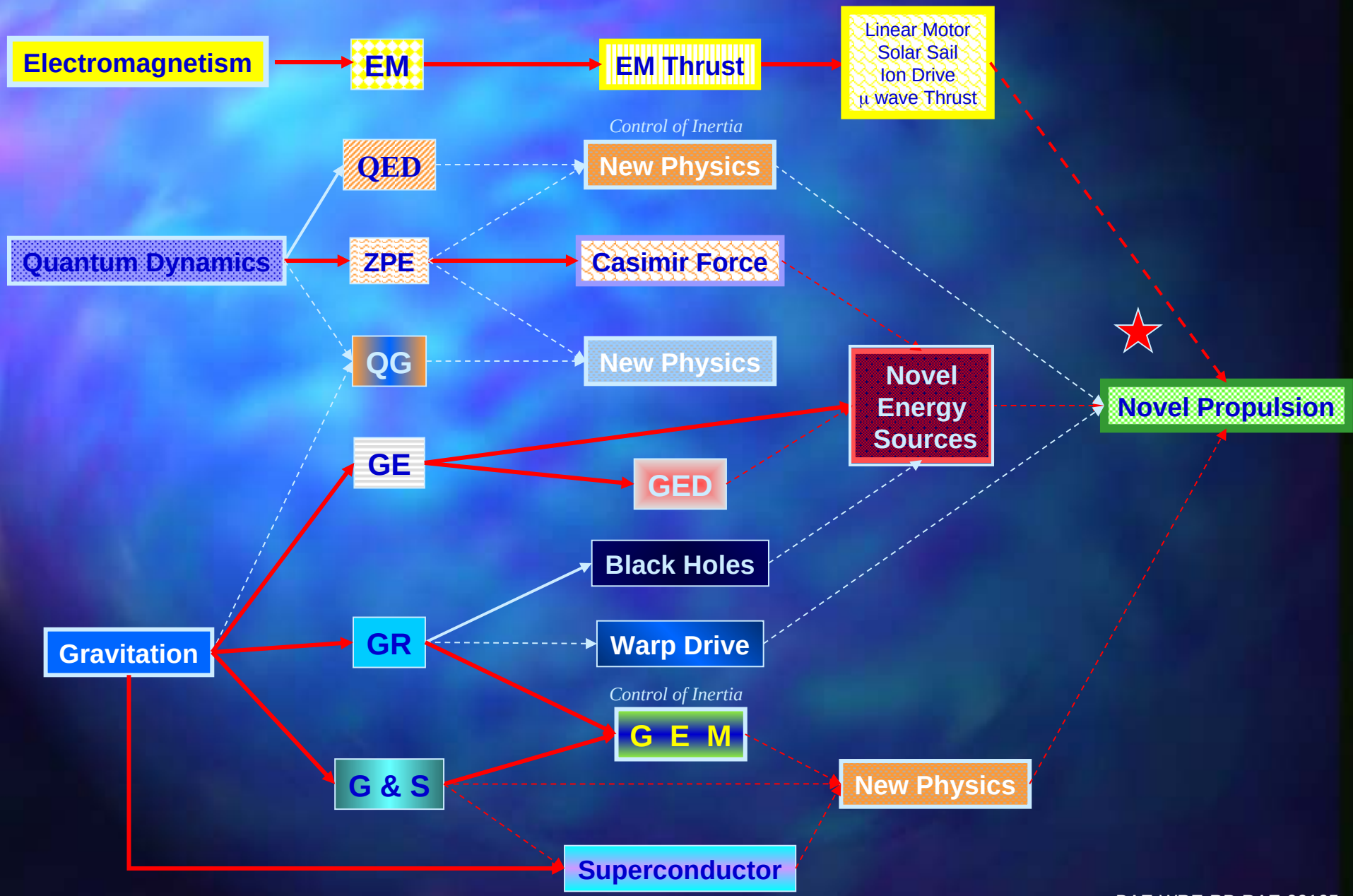
BAE SYSTEMS **Project GREENGLOW**

Start: 1997
(BAe - University Round Table 1991)

Goals:

1. **Field Propulsion.**
2. **New Energy Source.**
3. **Supersede global transport.**

GREENGLOW RESEARCH ROUTE MAP

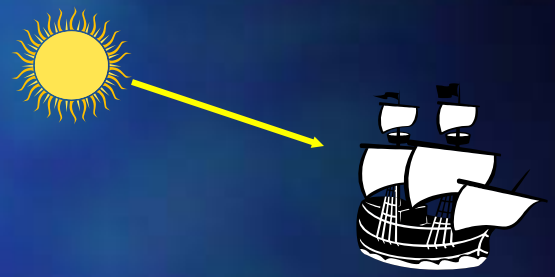


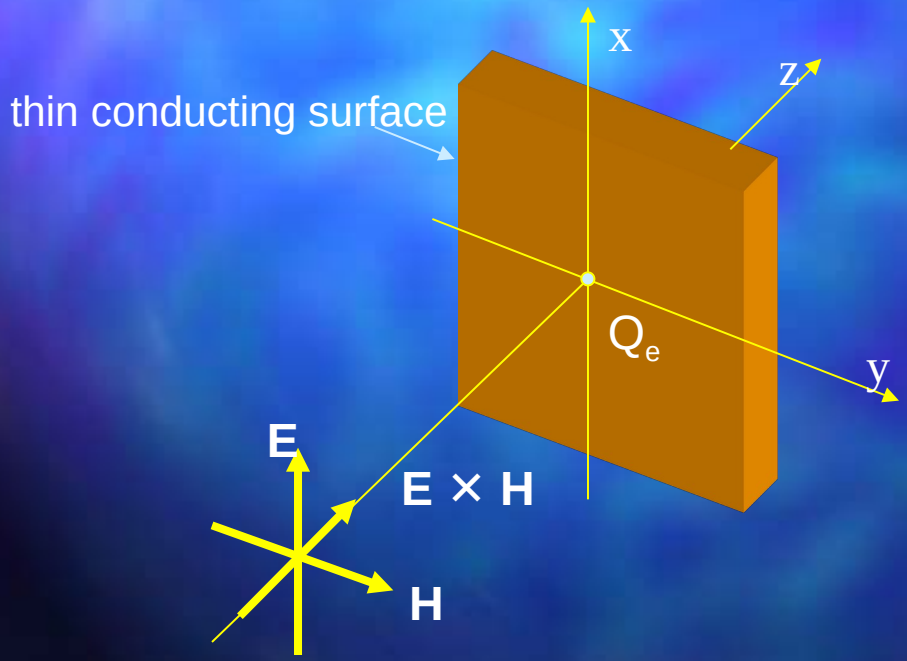
GREENGLOW 2000 - 03

RESEARCH	University
Microwave Thrust	Dundee / Strathclyde
Gravitation	Lancaster
Superconductivity	Sheffield
Casimir Force	Birmingham
Engineering Consultant	Kingston

Dundee & Strathclyde Universities

Theory & Experiment for a Microwave Thrust Device.





Radiation Pressure
(Ponderomotive Force)

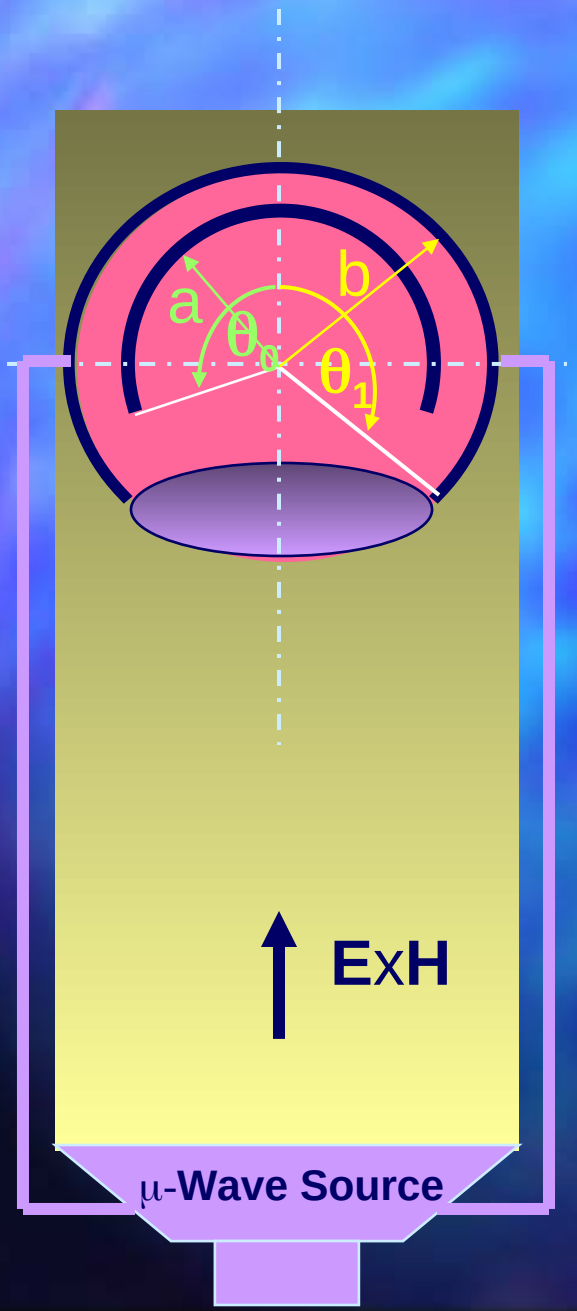
Lorentz Force

$$\mathbf{F} = Q_e(\mathbf{E} + \mu \mathbf{v} \times \mathbf{H})$$

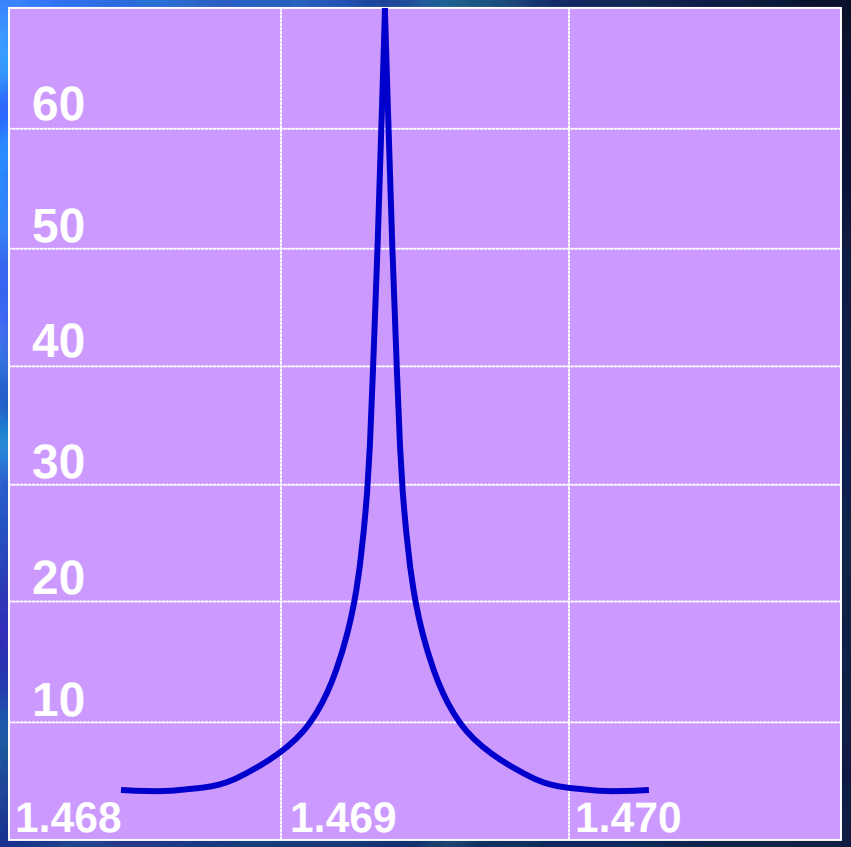
Force is in direction of propagation, since **H** and **v** in phase.

Dundee University

Open Cavity Resonance

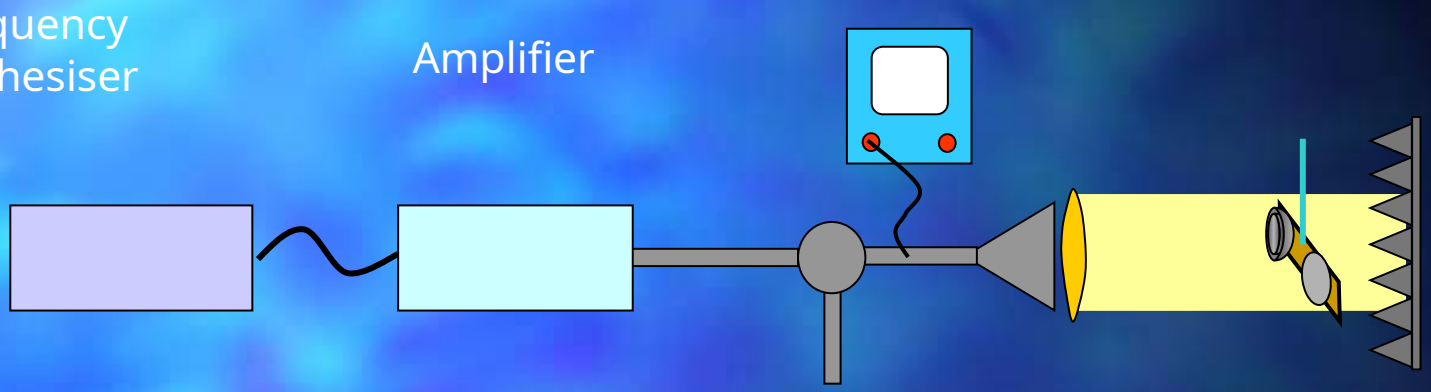


$\theta_0 = 160^o$ $\theta_1 = 90^o$ $q = a/b = 0.9$

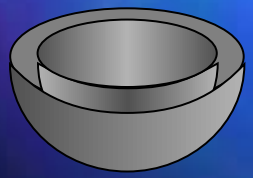


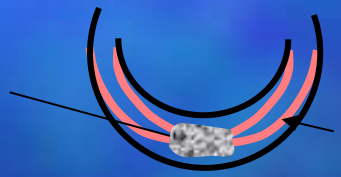
The Experiment

Strathclyde University

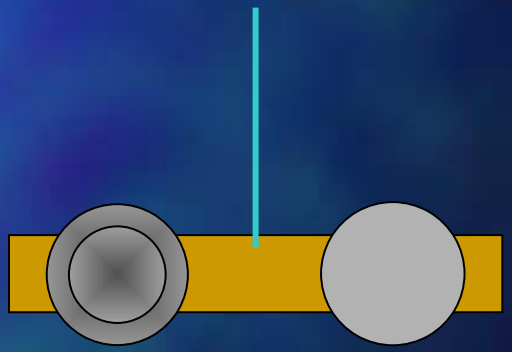


Experiment Schematic



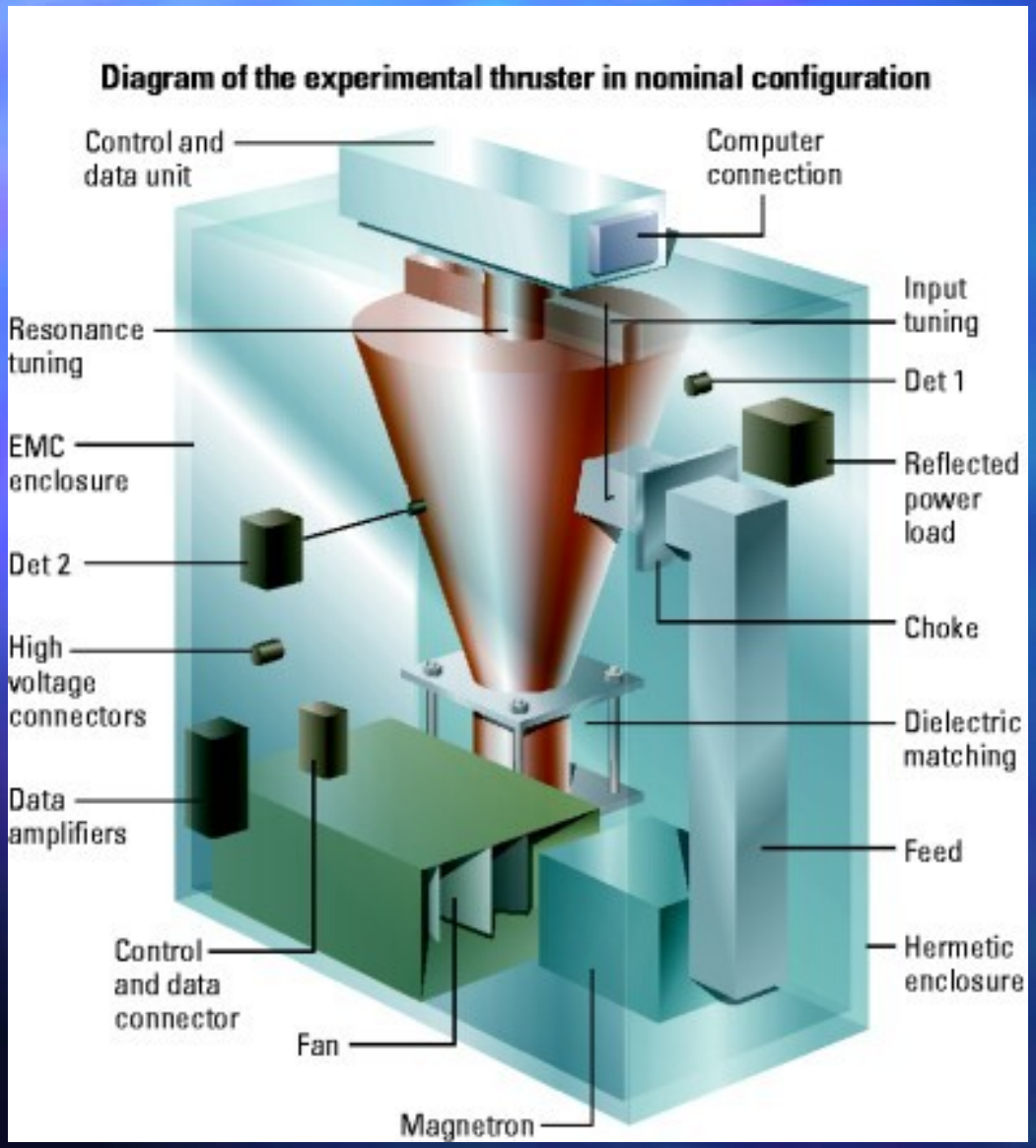


Open Cavity Resonator



Torsion Wire & Cross-bar

The EM Drive



Eureka

ISSUE: December 2002.

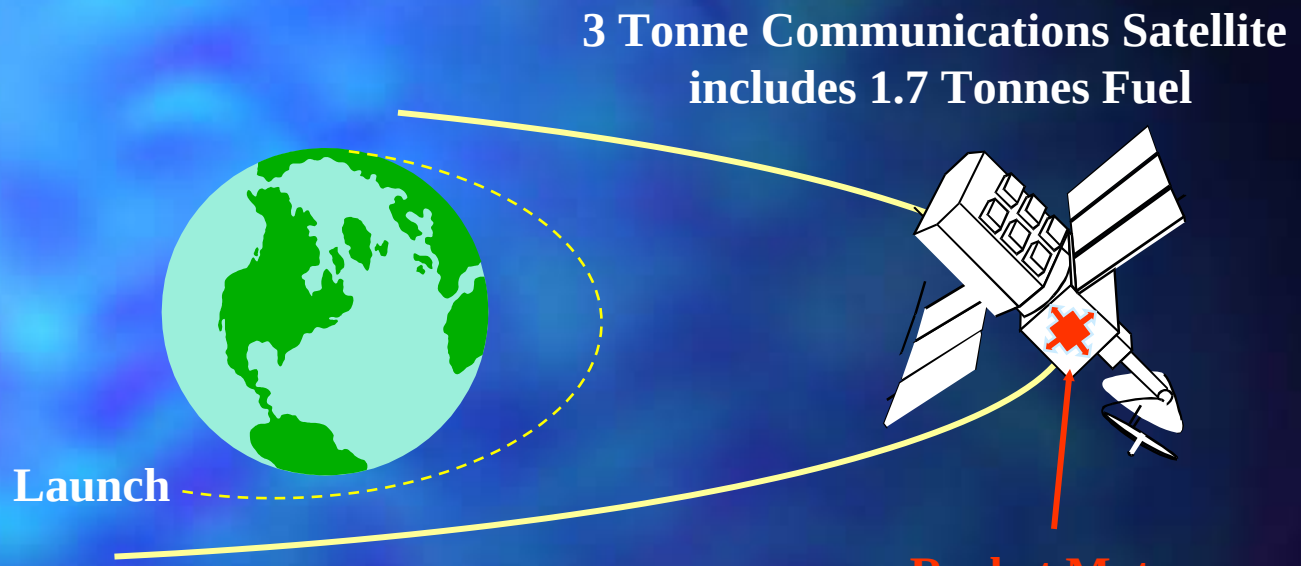
“ A force for space with no reaction”

Won DTI SMART Award

Device patented by Roger Shawyer, formerly the Project Manager for HOTBIRD at ASTRIUM.

From EUREKA Magazine

A Business Worth Pursuing?



Comms Sat. Launches = £10B/Yr.

EM Drive: Needs no Fuel, giving Longer Sat. Lifetime.

Lancaster University

Theoretical Studies

- Gravito-Elastodynamics (GED).

- Extraction of Energy from a Tidal Gravitational Field (GE).

- Use of Gravitational Energy for Propulsion (GEP).
  - Gravicraft Dynamics & Interplanetary Flight Control

- Gravitation Theory
  - Einstein's General Relativity (GR)
  - New Theories, including effect of Torsion & Spin (GS)
  - Maxwell Form of Gravitational Dynamics (GEM).
  - Formulation of Experimental Ideas

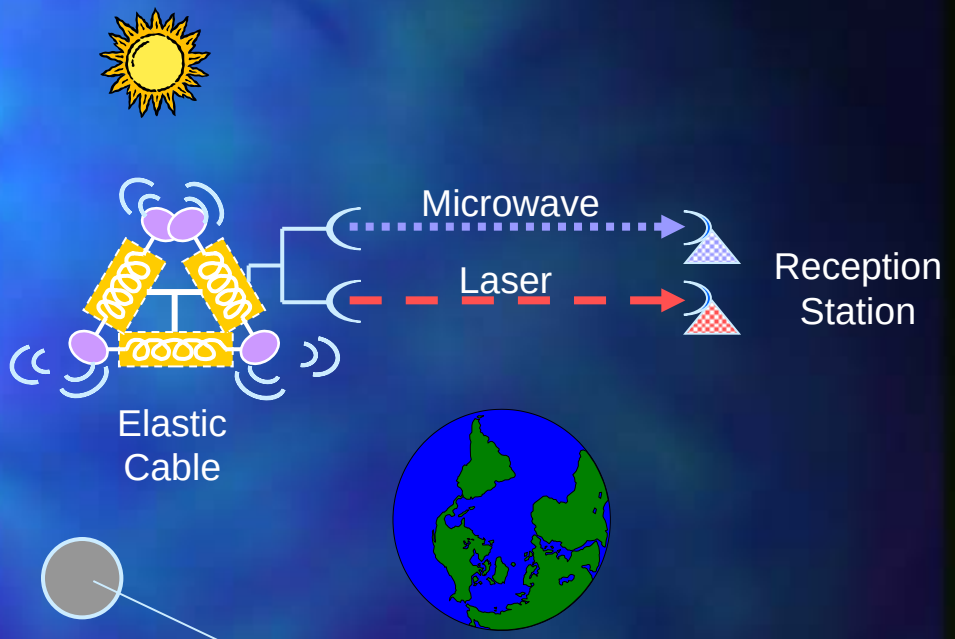
Tethers & Cables in Space

Lancaster University

Business Worth Pursuing?

Gravitational Tidal Power Induction

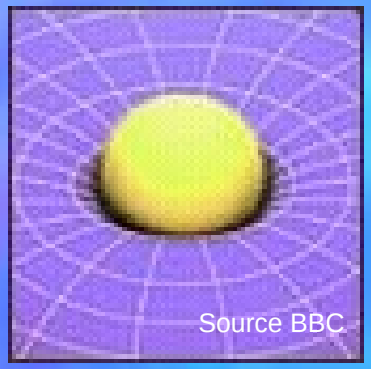
Tidal Gravitational Fields in Space offer a reservoir of accessible energy.



Gravicraft Dynamics

Gravicraft propulsion, which relies on a gravitational field, is achieved by varying the instantaneous moment of inertia of the rotating system.

Gravitation, Torsion & Spin



Rubber-sheet Analogy

CLASSICAL

Einstein's General Relativity.
Gravitation described in terms of the curvature of Space-time (x,y,z,ict), identifying gravitational sources with mass energy.

Cartan's Modification.
Torsion (a twist in Space-time), added to General Relativity, where the sources are identified with spinning matter.

FERMIONS Multiples of ½ integer spin		
Leptons	Electron Neutron Proton	
Quarks	UP	DOWN
	TOP	BOTTOM
	CHARM	STRANGE

BOSONS Multiples of integer spin	
EM	Photon
S	Gluon
W	W & Z
G	Graviton

QUANTUM

Spin.
A particle's intrinsic angular momentum, based on Planck's constant $\hbar$.

In general, Fermions obey the *Pauli Exclusion Principle*. No two fermions can have the same Quantum Number.
- Does not apply for Superconductors, where Bose - Einstein Condensates form.

Gravito-Electro-Magnetism

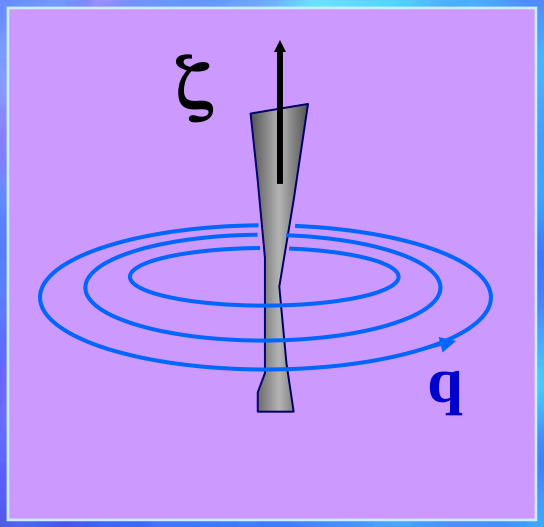
Incompressible Fluids	Electro-Magnetism (Fluids Analogue)	Linearised GR (EM Analogue)
$\nabla\times\boldsymbol{\zeta} = \frac{1}{\nu}\{***\} - \frac{1}{\nu}\frac{\partial \mathbf{q}}{\partial t}$	$\nabla\times\mathbf{E} = -\mu\frac{\partial \mathbf{H}}{\partial t}$	$\nabla\times\mathbf{G} = -\frac{1}{p}\frac{\partial \mathbf{H}}{\partial t} \approx 0$
$\nabla\cdot\boldsymbol{\zeta} = 0$	$\nabla\cdot\mathbf{E} = \frac{\rho}{\varepsilon}$	$\nabla\cdot\mathbf{G} = \rho G$
$\nabla\cdot\mathbf{q} = 0$	$\nabla\cdot\mathbf{H} = 0$	$\nabla\cdot\mathbf{H} = 0$
$\nabla\times\mathbf{q} = \boldsymbol{\zeta}$	$\nabla\times\mathbf{H} = \rho\mathbf{v} + \varepsilon\frac{\partial \mathbf{E}}{\partial t}$	$\nabla\times\mathbf{H} = \rho\mathbf{v} - \frac{1}{G}\frac{\partial \mathbf{G}}{\partial t}$

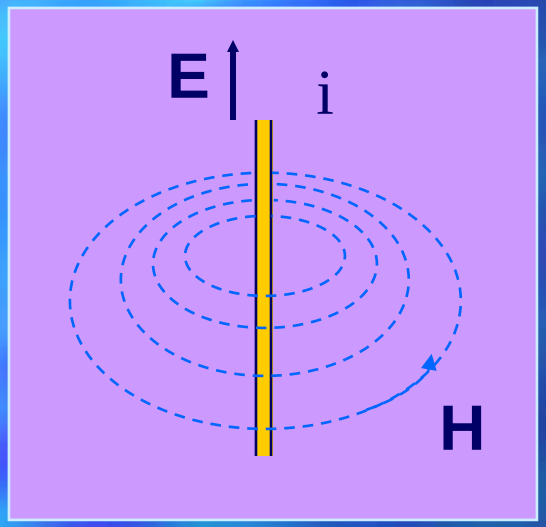
Classical Field Theory

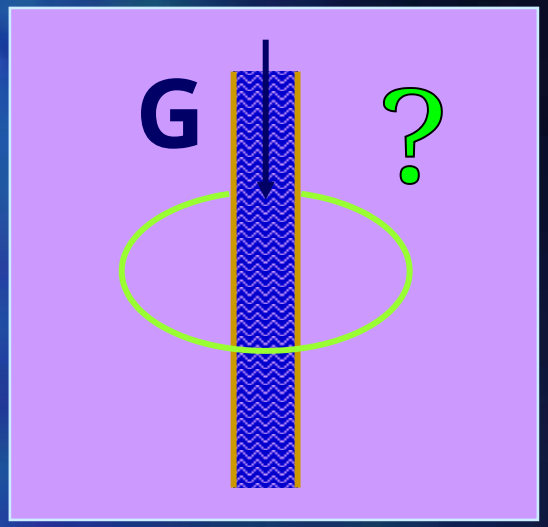
$\hbar$ QUANTUM

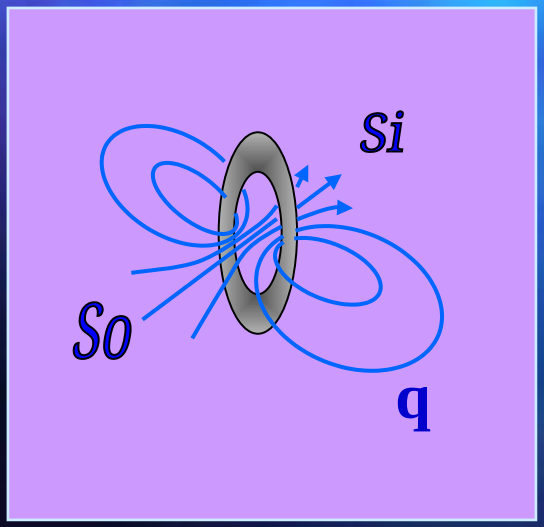
H is an undetected Force Field associated with Angular Momentum Density.

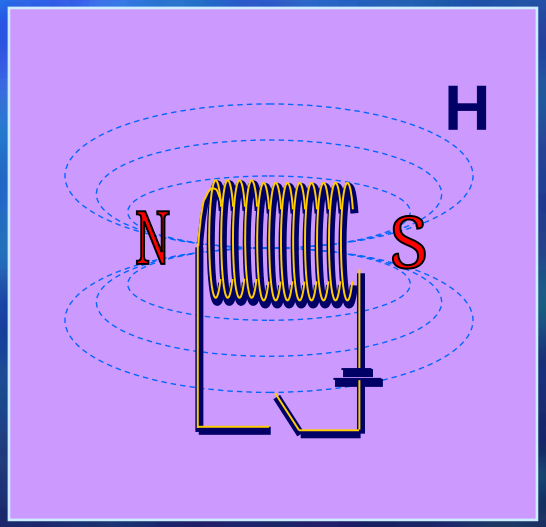
The Vortex

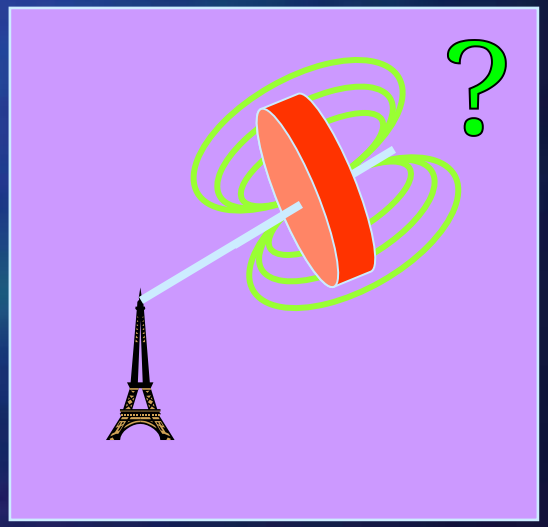




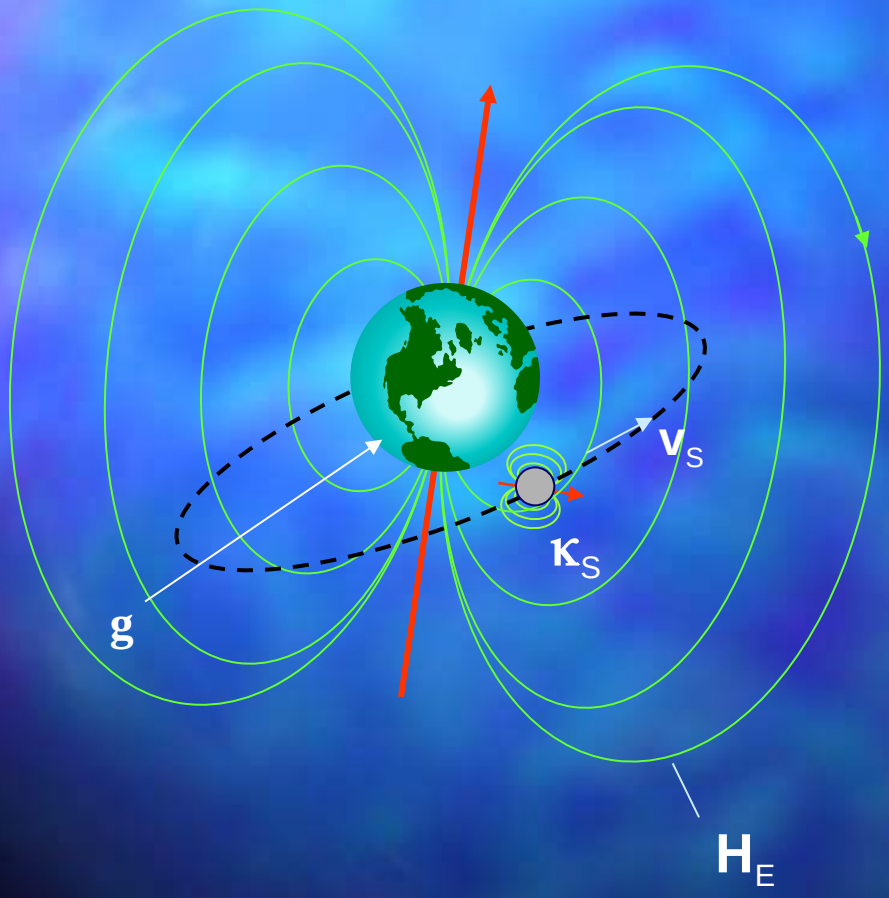








Experiment to detect gravito-magnetism.



NASA Gravity Probe-B Experiment

The Lense - Thirring Effect.

The spinning sphere has a gravitomagnetic dipole moment κ_S. In the Earth's gravitomagnetic field, the body will experience a couple C, given by $C = \kappa_S \times H_E$

The predicted movement of the sphere's Angular Momentum Vector is **0.042 sec/year**

Also, a predicted Space Curvature Effect of **6.6 sec/year**

No interest in Gravitomagnetism ?

On the Contrary!

Field Propulsion

If a Body's Gravitomagnetic Field can be altered, then its inertia can be controlled, giving rise to a means of thrust.

Counter-Stealth

All Bodies have a Gravitational Signature - but short range.
Do they have a Gravitomagnetic Signature ?
Consider analogue of MAD.

ESA "HYPER" Mission - Atomic Gyroscopes H_E

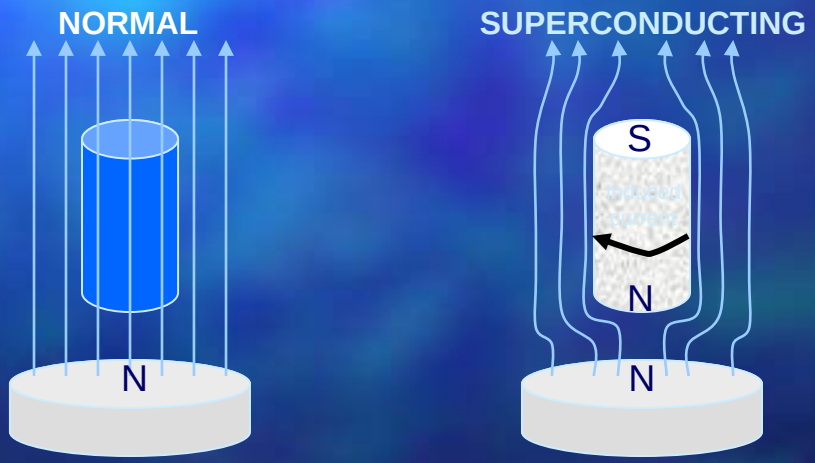
GREENGLOW ➡ BREAKTHROUGH DIRECTED RESEARCH

Sheffield University

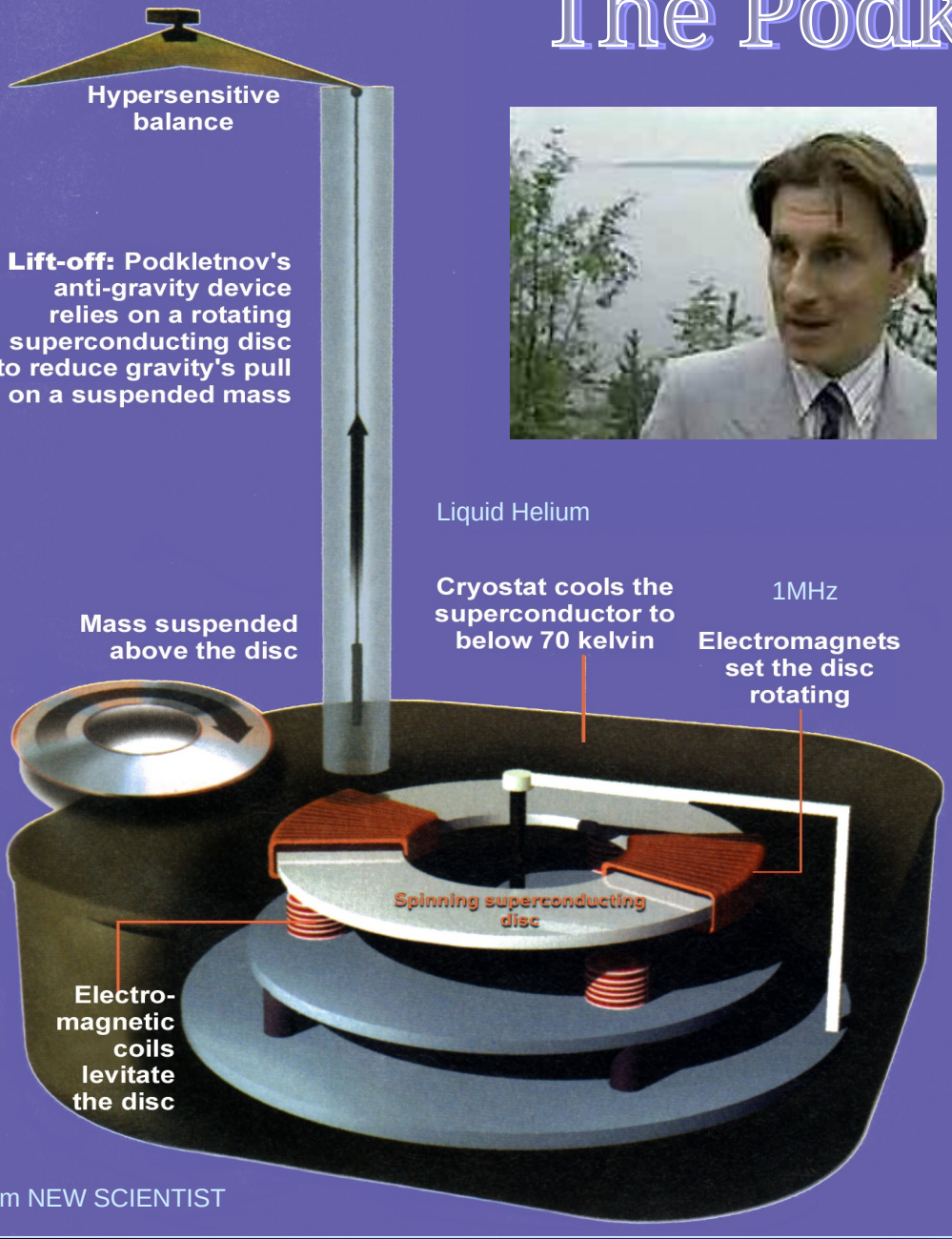
Experimental Study

An Investigation of the PODKLETNOV Effect -

Gravitational Shielding caused by a Rotating Superconductor.



The Podkletnov Effect



Test Masses placed above the levitated YBCO toroid disc lost up to 0.5% of their weight at 5000 rpm.

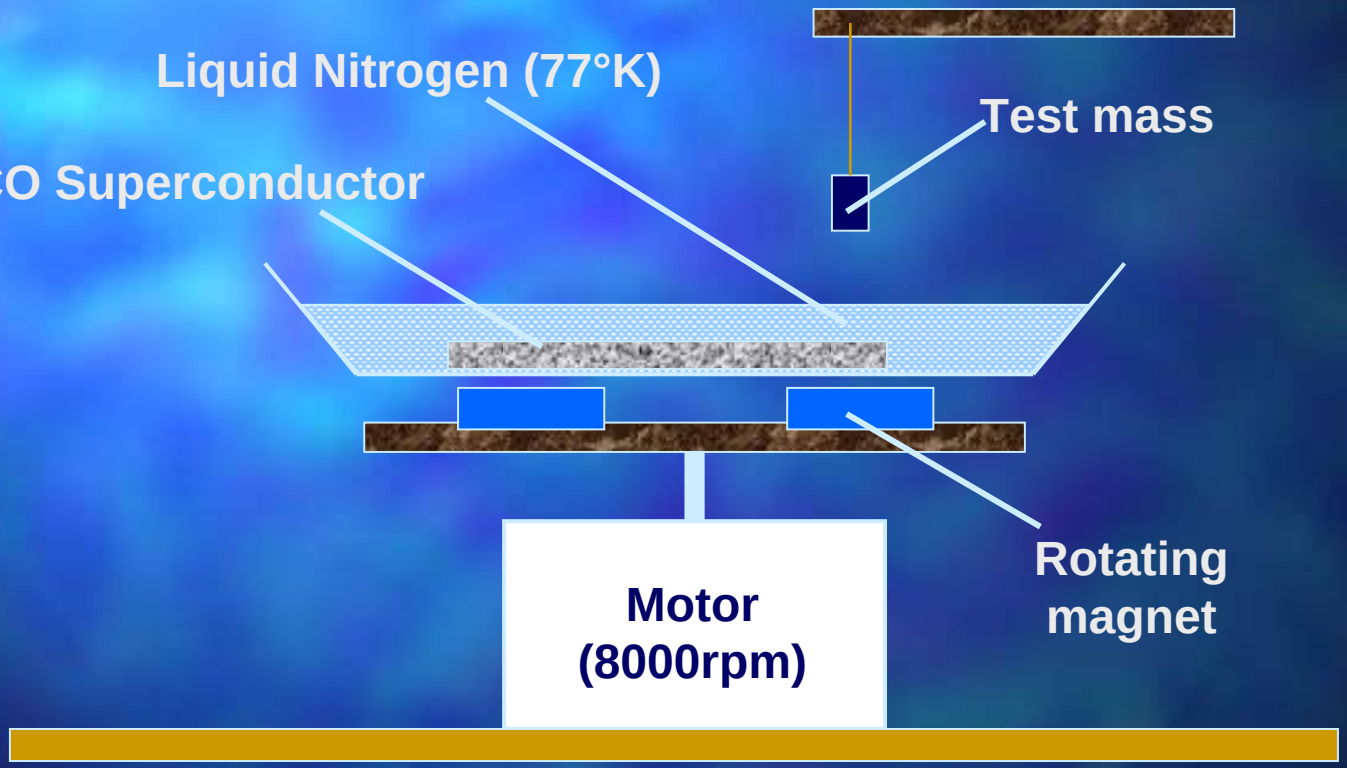
At other rpm, up to 2% weight loss has been measured.

Groups interested:

Sheffield/ Iowa University
NASA Huntsville
Alabama University
California University
US Army
TOSHIBA
BOEING
PIRELLI
MoD

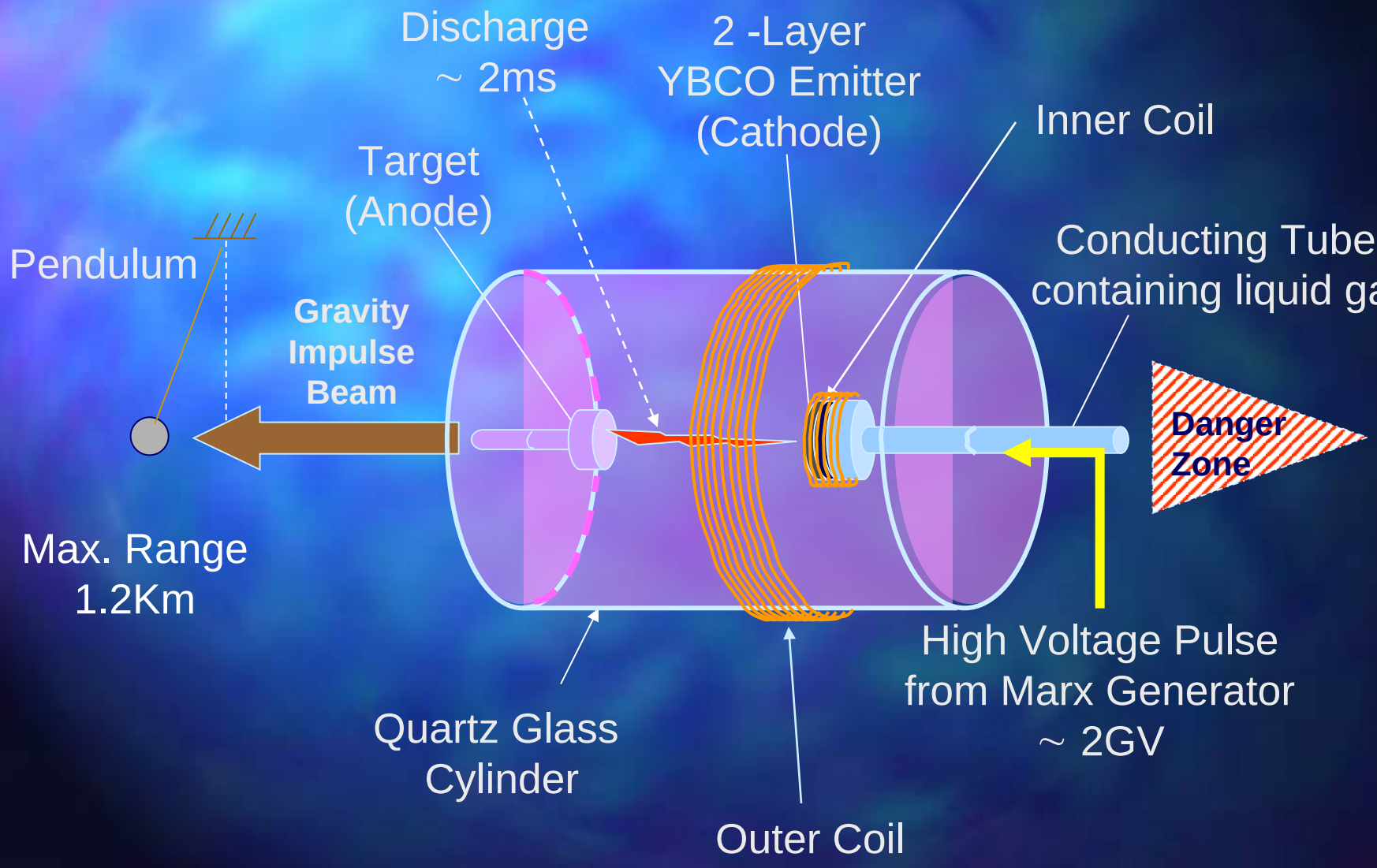
Simple Experimental Set-up

Sheffield University



No weight change detected

PODKLETNOV Gravity Impulse Generator



Science Fiction

Speculation

Truth : Innovation occurs after BREAKTHROUGH

Some Potential Applications

- Entertainment
- Artificial Inertia
- G-Force Control
- Vehicle Propulsion
- Beam Weapons
- Shielding Systems
- Lifts
- Zero-G formed Materials

Birmingham University

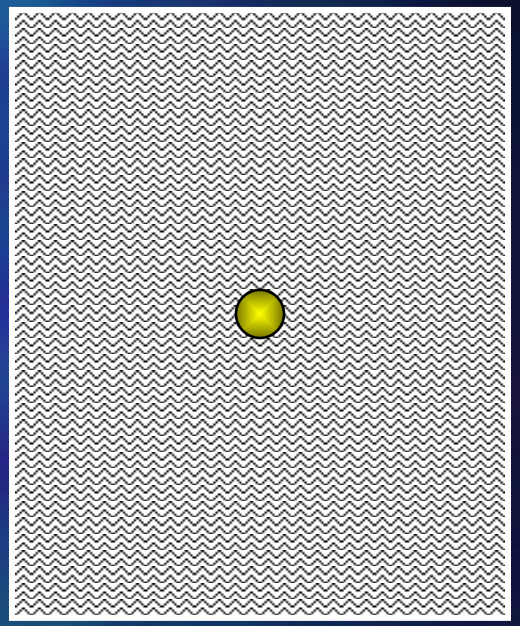
Measurement & Exploration of the Casimir Force

Search for Weak Forces

Investigation of ZPE

Extraction of Vacuum Energy

The Vacuum



A Sea of Virtual Photons

$$\Delta E.\Delta t \leq \hbar$$

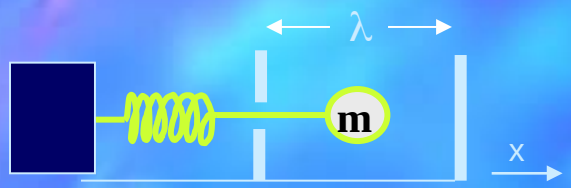
BAE SYSTEMS

PPARC

Leverhulme Trust

ZERO POINT ENERGY

CLASSICAL MECHANICS



Simple Oscillator

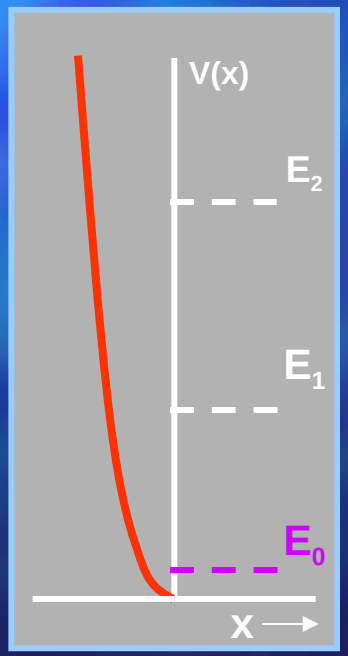
$$m\frac{d^2x}{dt^2} = -cx$$

ENERGY = T + V

$E = \frac{1}{2}mv^2 + \frac{1}{2}cx^2$

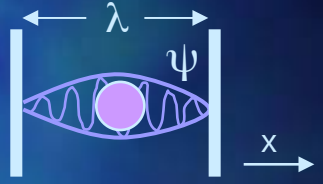
ZPE = E(T=0°) = 0

CONTINUOUS



DISCRETE

QUANTUM MECHANICS



Planck Oscillator

WAVES
$\lambda = 2\pi/k$

MATTER
$\lambda = h/p$
$p = mv$

$$\frac{d^2\psi}{dx^2} + k\psi^2 = 0$$

ENERGY = T + V

$E = \frac{1}{2}mv^2 + V$

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E - V)\psi = 0$$

$$E_n = (n + \tfrac{1}{2})\hbar\omega$$

ZPE = $E_0 = \frac{1}{2}\hbar\omega$
for all ω within cavity.

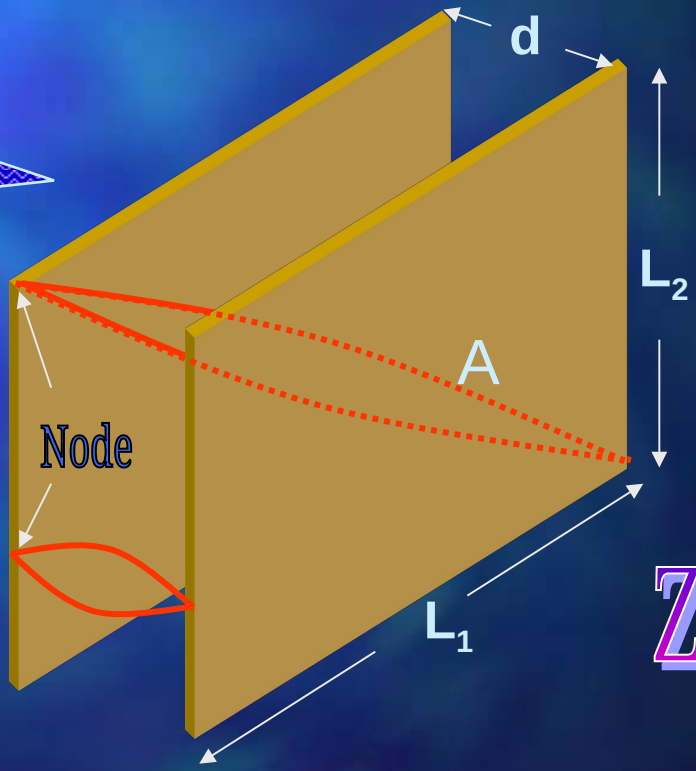
The Casimir Force

According to Quantum Theory, Vacuum Energy at 0°K = ½Σħω.

For two close uncharged conducting parallel plates, ony certain quantum fluctuations can fit in. Therefore radiation pressure outside must be greater than inside & the plates are pushed together.

$$F = \frac{\pi^2 \hbar c}{240\, d^4} A$$

d (m)	F/A (N/m²)
1	1.3×10^{-27}
10^{-6}	1.3×10^{-3}
10^{-9}	1.3×10^{9}

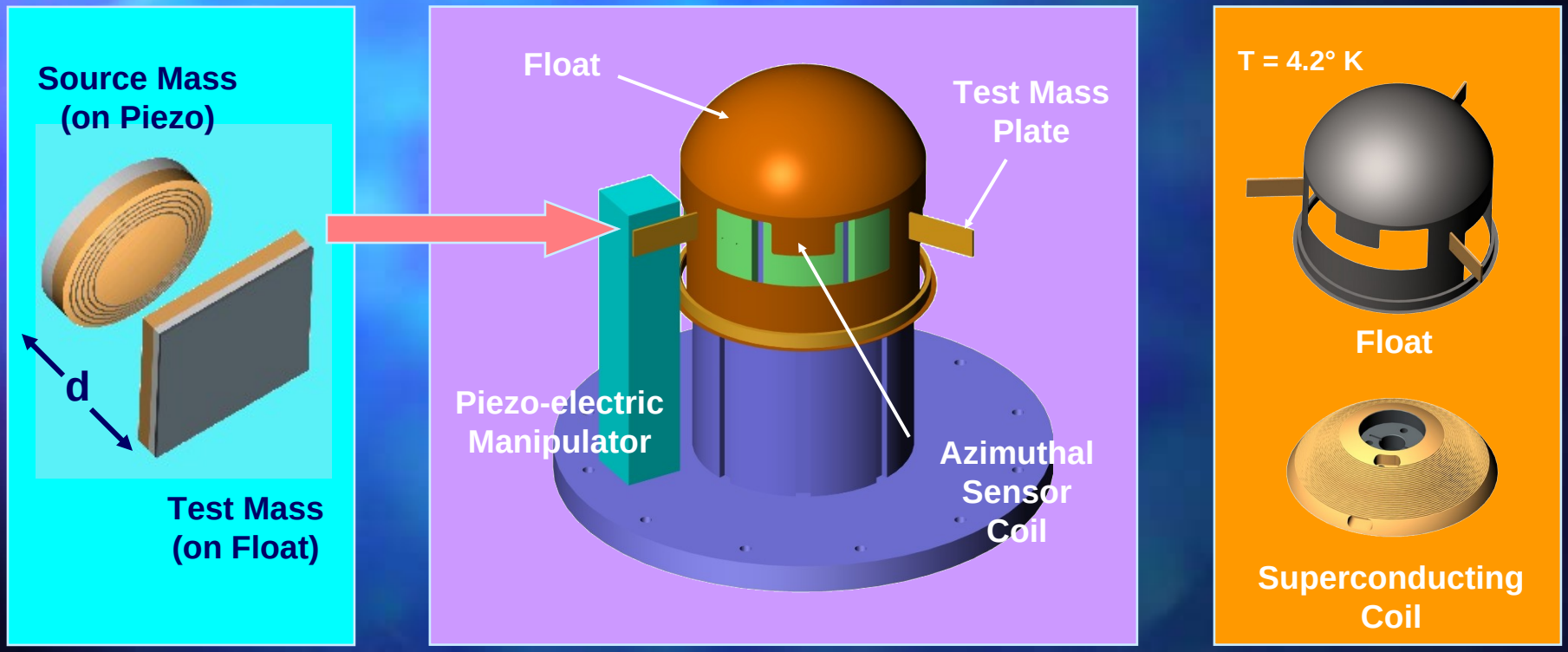


ZPE

More Modes outside, than inside

Measuring the Casimir Force using a SSTB.

Birmingham University

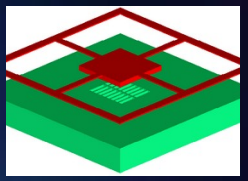


Force Feedback System to maintain gap width = d.

Micro Engines driven by ZPE

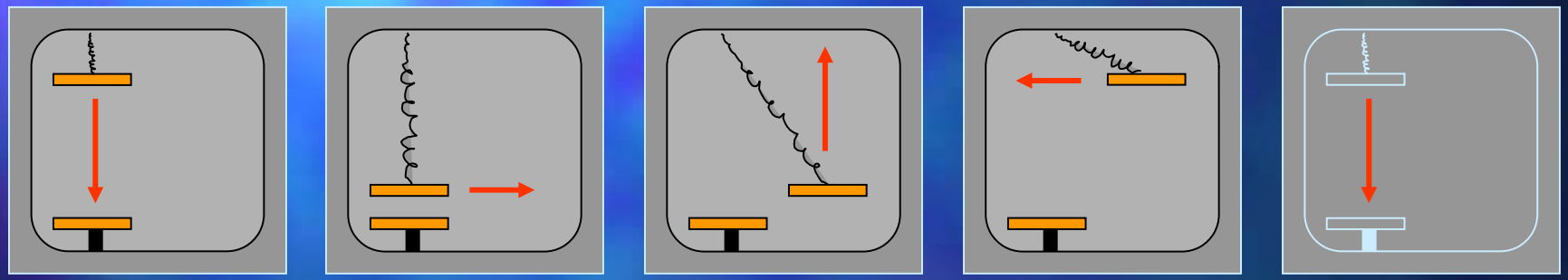
MEMS Devices for Sensors & Actuators.

- For 10^{-6}, Structures obey Classical Laws.
- For 10^{-9}, Structures obey Quantum-Classical Laws.



Maclay

Is it possible to build a MEMS Oscillator driven by ZPE?

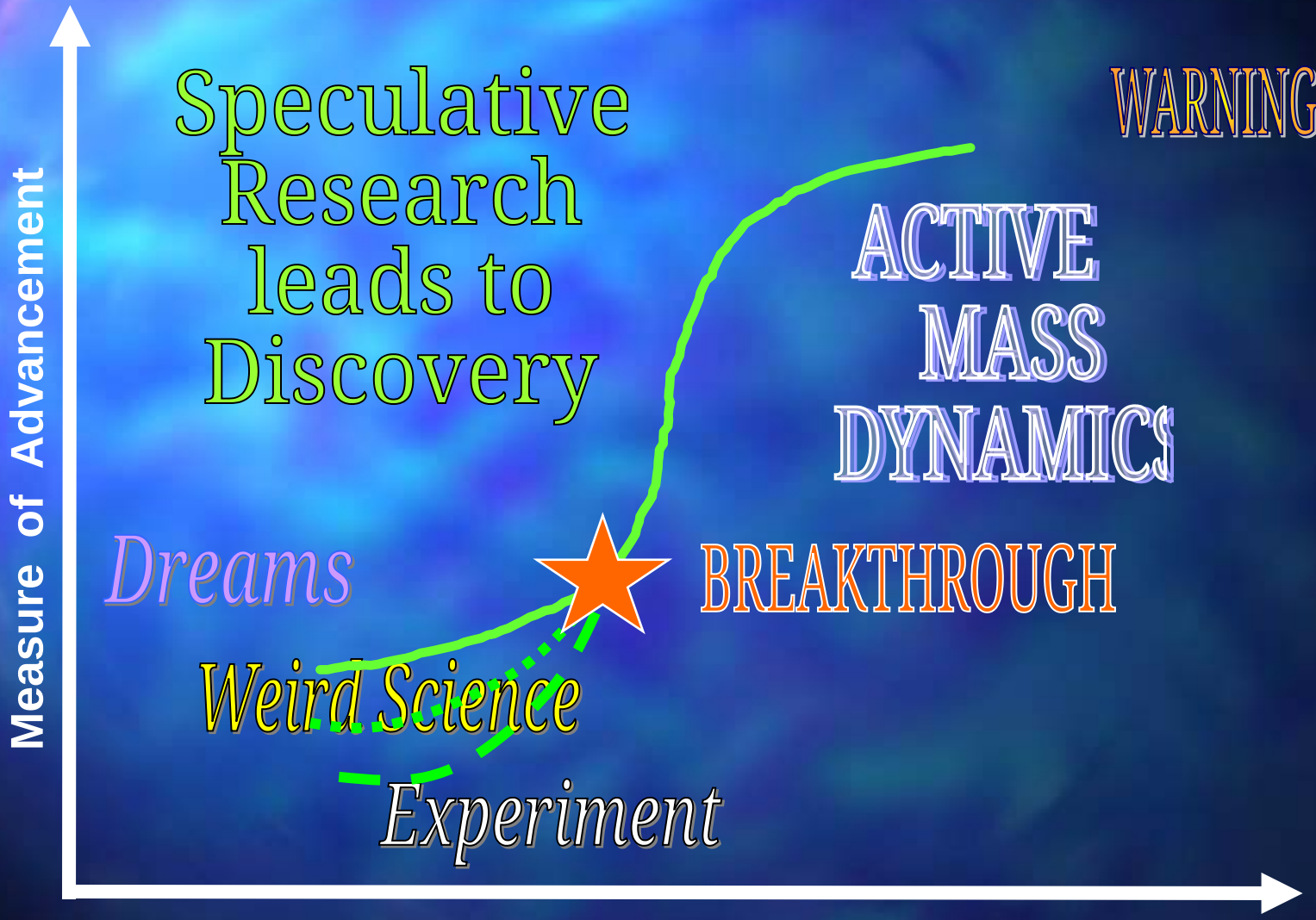


Can Energy be extracted from the Vacuum to keep Oscillator going?

Vacuum Shearing? **What about Quantum Friction?**

BAE SYSTEMS

New Technology Curve



Not if, but when !

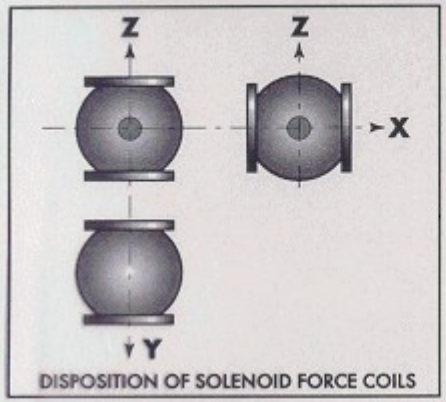
We are not alone !

IoP — **Gravitational Physics Group** — **BAE SYSTEMS**

NASA — **BPP Research Program for 2001 - 2002.**

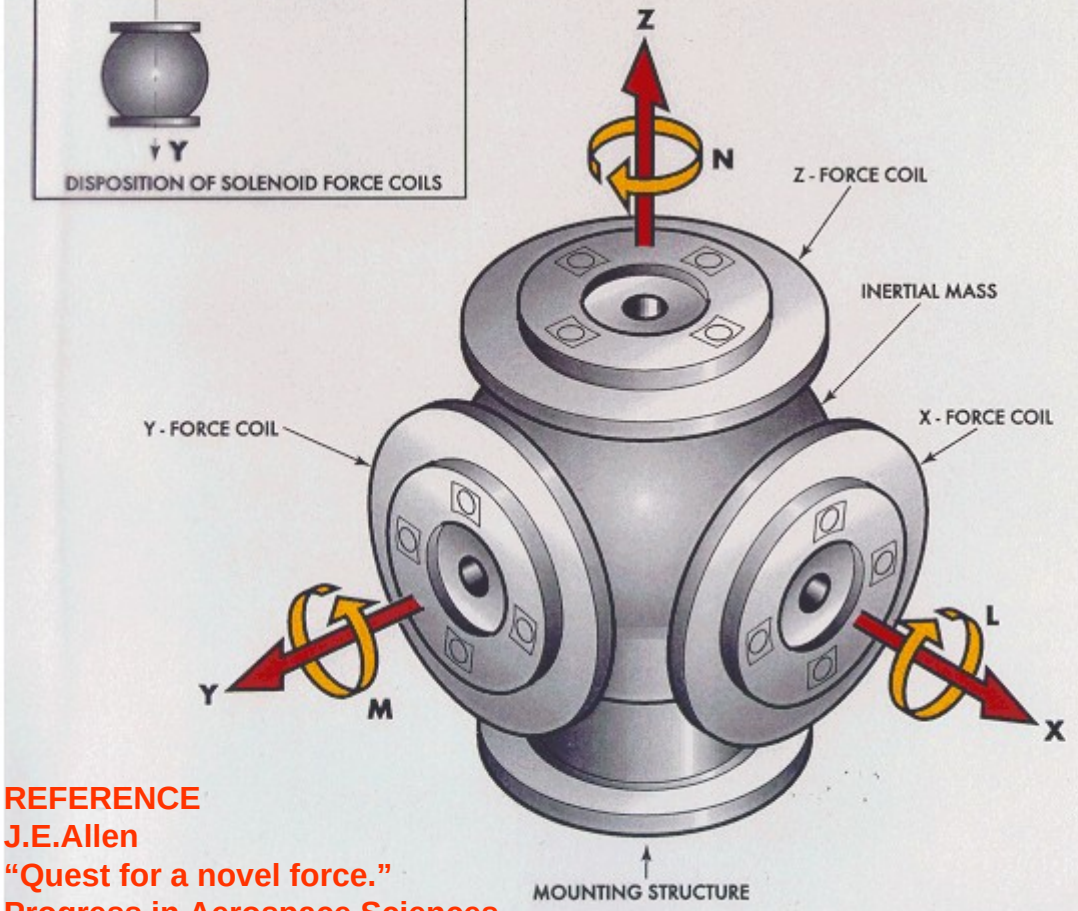
BOEING — **GRASP Report**
Gravity Research for Advanced Space Propulsion.
March 2002.

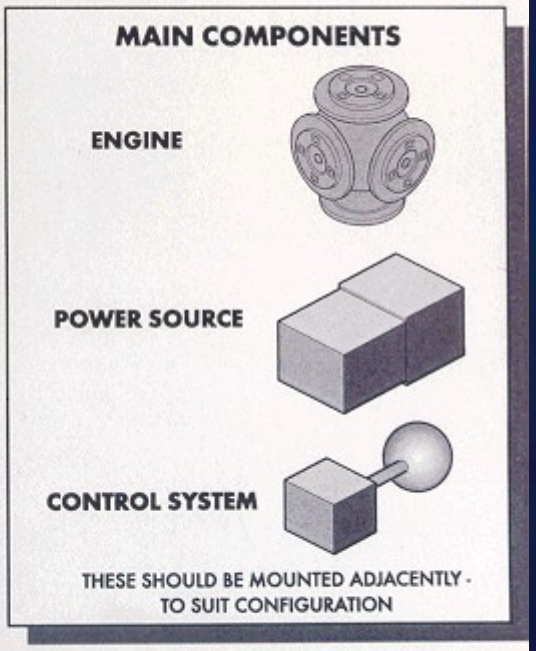
ESA — **ESTEC Report**
Gravity Control & Possible Influence
on Space Propulsion.
April 2002.



INERTIAL DRIVE ENGINE

" What - if ?" Design Studies

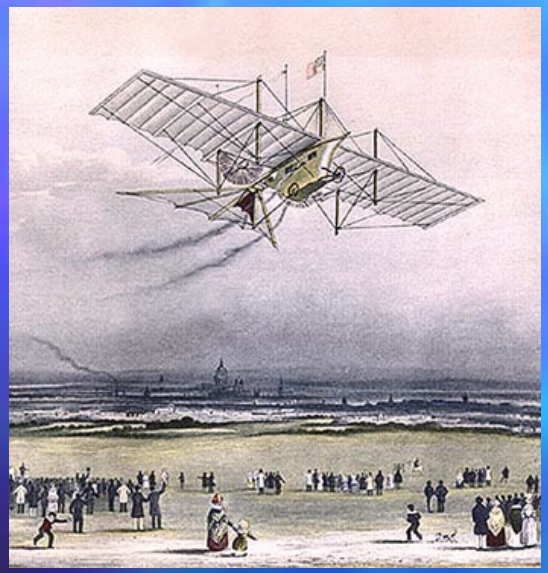




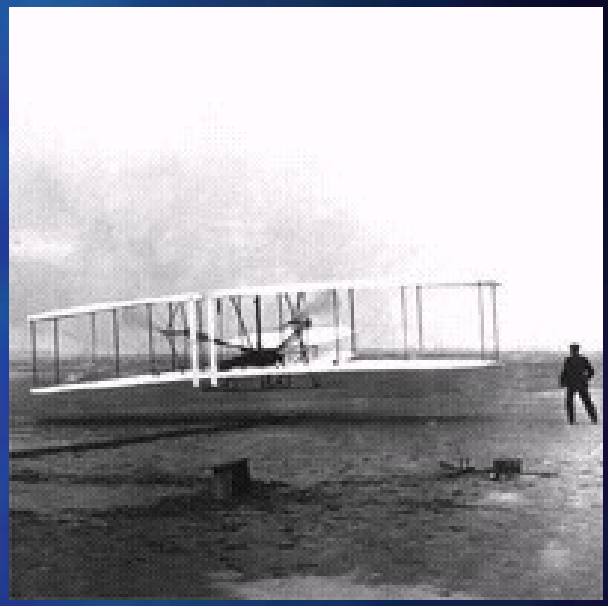
REFERENCE
J.E.Allen
"Quest for a novel force."
Progress in Aerospace Sciences
2003.

AERONAUTICS

A previous BREAKTHROUGH !



400BC		Chinese Kites
1804		Cayley's Kites
1848		Henson & Stringfellow Aerial Steam Carriage
1853		Cayley's Glider Coachman's Flight
1884	★	Daimler's Petrol Engine
1894		Maxim's Bi-plane Steam powered
1903	★	The Wright Brothers The Flyer



Quote by Wilbur Wright :

"In 1902, I confess that I said to my brother Orville that man would not fly for fifty years. Two years later we made flights. This demonstration of my impotence as a prophet gave me such a shock that never more have I trusted myself and avoided all predictions."