

# EM Vortex Tube as Propulsion Device in Scalar-Tensor Gravity

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# The EM Drive Idea

- Inventor: British Aerospace Eng. Roger Shawyer
- <https://en.wikipedia.org/wiki/EmDrive>
- Proposed Asymmetric Waveguide



- DTI Fund: 1<sup>st</sup> prototype 2002
- Chinese prototype 2008, NW Polytechnic Xi' an Province.
- NASA 'Skunkworks' replication, 2014, Harold "Sonny" White

# Critics & Solutions

- Apparent violation of conservation of momentum ('Reactionless' Drive.)
- First prominent solution by Fernando Oscar Minotti, CONICET, Buenos Aires, Grav. & Cosmol. 19 (2013) 201, “**Scalar-tensor theories and asymmetric resonant cavities,**”  
[<http://arxiv.org/abs/1302.5690>]
- Theory based on previous work by J.P. Mbelek and Lachieze-Rey.

# Joint Work 2013

- Two Table-To experiments proposed by Minotti, Raptis.
- ***“Possible measurable effects of light propagating in electromagnetized vacuum, as predicted by a scalar tensor theory of gravitation.”***, Class. Quantum Grav. 30 (2013) 235004, [[arXiv:1305.7141](https://arxiv.org/abs/1305.7141) [gr-qc]].
- ***“Transient force effects, as predicted by Mbelek and Lachièze-Rey scalar tensor theory of gravitation,”*** [[arXiv:1310.5029](https://arxiv.org/abs/1310.5029) [gr-qc]]

# Recent 'alarming' indications

- P. Jofre, A. Reisenegger, R. Fernandez, “**Constraining a possible time-variation of the gravitational constant through "gravitochemical heating" of neutron stars**”, Phys.Rev.Lett. 97 (2006) 131102, [arXiv:astro-ph/0606708](https://arxiv.org/abs/astro-ph/0606708)
- Lorenzo Iorio, “**Does the Newton's gravitational constant vary sinusoidally with time? An independent test with planetary orbital motions**”, [rXiv:1504.07233](https://arxiv.org/abs/1504.07233) [gr-qc]
- S. Schlamminger, J.H. Gundlach, R.D. Newman, “***Recent measurements of the gravitational constant as a function of time***”, Phys. Rev. D 91, 121101 (2015), [arXiv:1505.01774](https://arxiv.org/abs/1505.01774) [gr-qc].

# Possible Alternative to EMdrive

- Solitary Surface Waves on Controllable Materials/Meta-materials.
- Non-Diffracting Waves: J. N. Brittingham, '*Focused Wave Modes*', (1983), J. Lu & Greenleaf, "*X-Waves*" (1992), I. M. Besieris, A. M. Saarawi, R. W. Ziolkowski (90s), "*Localized Null EM Waves*".
- Non-Null Parallel E and B Waves :('Beltrami' Modes) K. Shimoda, K. Uehara, T. Kawai, 1989, General Solutions, T. Noshiyama (2015).

# The Hydrodynamic Connection

- Maxwell field as an ideal Eulerian Fluid.
- Haralambos Marmanis, “*Analogy between the Navier–Stokes equations and Maxwell’s equations: Application to turbulence*”, Phys. Fluids **10**, 1428 (1998)
- Tsutomu Kambe, “*Variational formulation of an ideal fluid and fluid Maxwell equations*”, <http://www.purple.dti.ne.jp/kambe/>
- *The Beltrami Helical Flow Connection*: Arkady Kholodenko, “*Applications of Contact Geometry and Topology in Physics*”, World Sci. (2013)

<http://www.worldscientific.com/worldscibooks/10.1142/8514>

- Shimoda, Uehara and Nishiyama, apply the Beltrami Constraint directly to E or B fields (*“Force-Free Condition”*  $\mathbf{J} \times \mathbf{B} = 0$ )
- Applying it directly to the *Vector Potential* leads to peculiar type of localized sources travelling with the fields (*“EM bullets”*).

$$\nabla \times \mathbf{A}(x_i - vt) = \lambda(x_i - vt)\mathbf{A}(x_i - vt)$$

$$\nabla \lambda \cdot \mathbf{A} = \nabla \cdot \mathbf{A} = 0$$

- *“Eigen-Vorticity”*  $\lambda$  appears as an additional degree of freedom for the non-homogeneous 2<sup>nd</sup> order wave operator.



# Possible Generalizations

- Is there a 4D equivalent?
- Pick up an arbitrary 4-vector  $\kappa_\nu$  such that

$$\partial_\mu \mathbf{a}_\nu - \partial_\nu \mathbf{a}_\mu = \kappa_\mu \mathbf{a}_\nu - \kappa_\nu \mathbf{a}_\mu$$

- Additional vector could be a dual such that

$$F_{\mu\nu}(\mathbf{a}) = -F_{\mu\nu}(\kappa)$$

- Symmetry:  $(\partial_\mu - \kappa_\mu) \mathbf{a}_\nu = (\partial_\nu - \kappa_\nu) \mathbf{a}_\mu$
- One could also choose a connection such that

$$\nabla_\mu \mathbf{a}_\nu = \nabla_\nu \mathbf{a}_\mu$$

- Two independent solutions for cylindrical and spherical systems ( $x_i \leftarrow \{z, r\}$ ).

$$y_{1,2} = \begin{cases} \sin(G(x_i - vt)) \\ \cos(G(x_i - vt)) \end{cases}, \quad G \leftarrow \int dx_i \lambda$$

- Localized Non-Diffractive Waves:

$$\mathbf{A}(x_i - vt) = g^{-1} \begin{bmatrix} ay_1 \pm by_2 \\ ay_1 \mp by_2 \\ 0 \end{bmatrix}, \quad \mathbf{B} \sim \lambda \mathbf{A}, \quad \mathbf{E} \sim -\partial_t \mathbf{A}$$

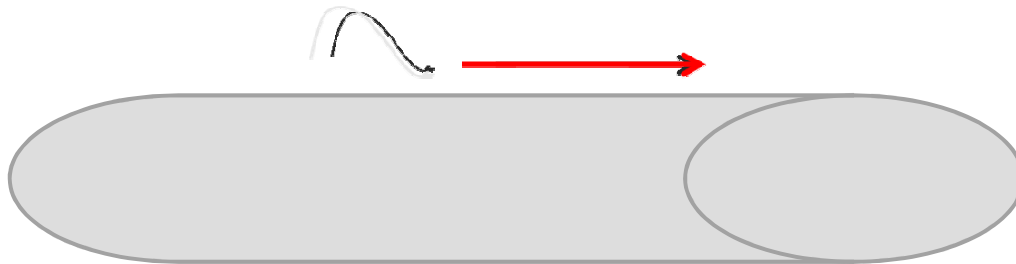
$$(\nabla^2 - v^{-2} \partial_t^2) \mathbf{A} \equiv (\nabla^2 - c^{-2} \partial_t^2) \mathbf{A} - \tilde{\mathbf{J}} = 0$$

$$\tilde{\mathbf{J}} = c^{-2} (1 - \beta^2) \mathbf{A}$$

- Subluminal, luminal and superluminal versions possible. Sources vanish exactly at  $c$ .

# Possible GRW Generator

- In Mbelek-Rey-Minotti scalar-tensor variety, Maxwell vacuum functions as a polarizable medium.
- EM Backreaction to at least one of the three gravi-scalars.
- Gravi-scalar source term  $\sim |\mathbf{B}^2| - |\mathbf{E}^2/c^2|$ . Coupling coefficient estimated near  $[10^{-4} - 10^{-5}]$ .



# Existing Technology

- Experiments with Superluminal Polarization Currents:  
A. Ardavan *et al.*, “*Experimental demonstration of a new radiation mechanism: emission by an oscillating, accelerated, superluminal polarization current.*”  
[arXiv:physics/0405062](https://arxiv.org/abs/physics/0405062)
- Real Experiment Data available at:  
<http://public.lanl.gov/astroflash/pdf/pstlk27.pdf>
- Electronic Switching of polarization charges across a dielectric.

Time to reach the sky!



Thank you!