Emergence of Dark Current in Galactic Dynamics via "Faraday" Induction

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The Agenda

• Build on research having proposed a “Superconducting” Dark Sector:
  ➢ For example: Alexander & Smolin and also Vikram

• Classic Superconductivity requires a Vector Potential.
  ➢ I posit a gravitational vector potential “A_g” a la Proca
  ➢ It arises from “Faraday-like” induction by visible mass galactic current

• It can be that “dark photons” associated with A_g acquire mass:
  ➢ Via the Higgs/BCS mechanism

• Indeed, such photons may even be “bipolar”:
  ➢ With both positive and negative mass
Galactic Mass Induction

• Assume a simple prototype elliptical galaxy
  ➢ It consists of visible and dark matter

• Treat the visible galaxy in a very simple fashion:
  ➢ A disk of visible Mass, $M_G$, with radius $R_G$ rotates uniformly at frequency, $\omega_1$
  ➢ Moment of Inertia: $I_G = \frac{1}{2} M_G R_G^2$

• Analyze this system as a harmonic oscillator:
  ➢ Where mass appears as an “inductor”
  ➢ Gravitational potential defines “capacitance”
This approach informs us about a more complete model ...and possible experiment!

$M \equiv k \sqrt{L_1 L_2}$

L_1, L_2 & M are “masses”
The Coupled Parallel LCR circuit Model

\[ \varepsilon(\omega) = \varepsilon_0 e^{i\omega t} \]

\[ \varepsilon_0 = \frac{GM_g M\odot}{R^2\odot} \quad \rightarrow \text{Driving Force (Gravity)} \]

\[ Z_1(\omega)I_1(\omega) \pm i\omega M I_2(\omega) = \varepsilon(\omega) \]

\[ \mp i\omega M I_1(\omega) + Z_2(\omega)I_2(\omega) = 0 \]

\( I_2 \) is natural current induced by \( I_1 \) !!
More Model Detail deferred to “Extra” given time constraints
Set power ratios of Visible to Dark equal

\[ Q_1 = Q_2 \]

\[
R_1 = \frac{Q_1}{\sqrt{\frac{L_1}{C_1}}} = \frac{Q_1}{R_V} \rightarrow R_2
\]

\[
I_1 = \frac{\varepsilon(\omega)}{iR_1 \left[1 - k^2 \left(1 - \frac{L_2}{L_1} \right) \right]}
\]  

Visible Mass Current

\[
\frac{I_2}{I_1} = \pm k \sqrt{\frac{L_1}{L_2}} \left(1 - \frac{L_2}{L_1} \right)
\]  

Dark Mass Current
Dependence of Mass currents on Mass Impedance Ratio: $\frac{L_2}{L_1}$

**Observable Rotational Speed vs Impedance ratio**

$V_1$ @ $K=0$

$V_1$ @ $K=.05$

$V_1$ @ $K=0.1$

$V_1$ @ $K=0.2$

$V_1$ @ $K=0.3$

$V_1$ @ $K=0.4$

$V_1$ @ $K=0.5$

$V_1$ @ $K=0.7$

$V_1$ @ $K=0.9$

**Dark Rotational Speed vs Impedance ratio**

$V_2$ @ $K=0.1$

$V_2$ @ $K=0.05$

$V_2$ @ $K=0.2$

$V_2$ @ $K=0.3$

$V_2$ @ $K=0.4$

$V_2$ @ $K=0.7$
Port the above insights to a “Real” Model

• Objective: Define an effective Galactic Potential vs R

• The reaction of the Dark sector to Visible mass induction is via $A_g(R)$

• Use the classic BCS superconducting Vector potential

• This is presented here as a work in progress

• But initial results meet expectations
Vector Potential (dynes-cm) vs R by “non-locality” factor $k = 0.5$

Nonlocality defines large spatial correlation of $L_1$ and $L_2$ “(BCS)”
Galactic Potential
Newtonian with/without Gravitational Vector Potential
Negative Mass density occurs!

-5.0E+14 -4.0E+14 -3.0E+14 -2.0E+14 -1.0E+14 0.0E+00 1.0E+14 2.0E+14 3.0E+14 4.0E+14 5.0E+14

Mass Density vs Radius

Newtonian PHI

Negative mass density
Summary
(#1 Thank you for your interest!)

• Dark Mass induction by the visible sector makes sense:
  ➢ *The visible (observed) mass current increases*

• The superconducting mechanism makes sense.

• It is hoped this work may be useful for the professional community.

• I believe that an enhanced circuit model can be explored in the lab!
  ➢ *Basically L2 in can be a Superconducting stripline*
  ➢ Run at Low Temp (< 4 K).
  ➢ I can draft the actual component list for interested parties!
Circuit elements in terms of mechanical analogues

\[ \Phi(R_G) = -\frac{G M_G M_\odot}{R_G} \]

\[ L_1 = M_\odot R_G^2 \quad C_1 = \sqrt{\frac{M_\odot}{|\Phi(R_G)|}} \]

\[ R_1 \equiv Q_1 \Omega_1 L_1 \text{ High } Q \text{ is stronger resonance} \]

Msol \sim 2E33 \text{ gm} \quad MG \sim 1.5E44 \text{ gm}

We find the time constant \((R1 \times C1)\) to achieve resonance \sim 10^9 \text{ years}
Impedances in Parallel

\[
\frac{1}{Z_1(\omega)} = \frac{1}{R_1} + \frac{1}{i\omega L_1} + i\omega C_1
\]

\[
\frac{1}{Z_2(\omega)} = \frac{1}{R_2} + \frac{1}{i\omega L_2} + i\omega C_2
\]

\[\Omega_1 \equiv \frac{1}{\sqrt{L_1 C_1}} \quad \Omega_2 \equiv \frac{1}{\sqrt{L_2 C_2}}\]

\(\omega \to \Omega_1 \quad Z_1 \to \sqrt{\frac{L_1}{C_1}}\)

\(\leftarrow \text{Impedance of the Visible sector “Rv”}\)
A Variety of possible Rotation scenarios may be accessible to detection in Galactic structure (via Lensing?)