Two states of the neutrino background

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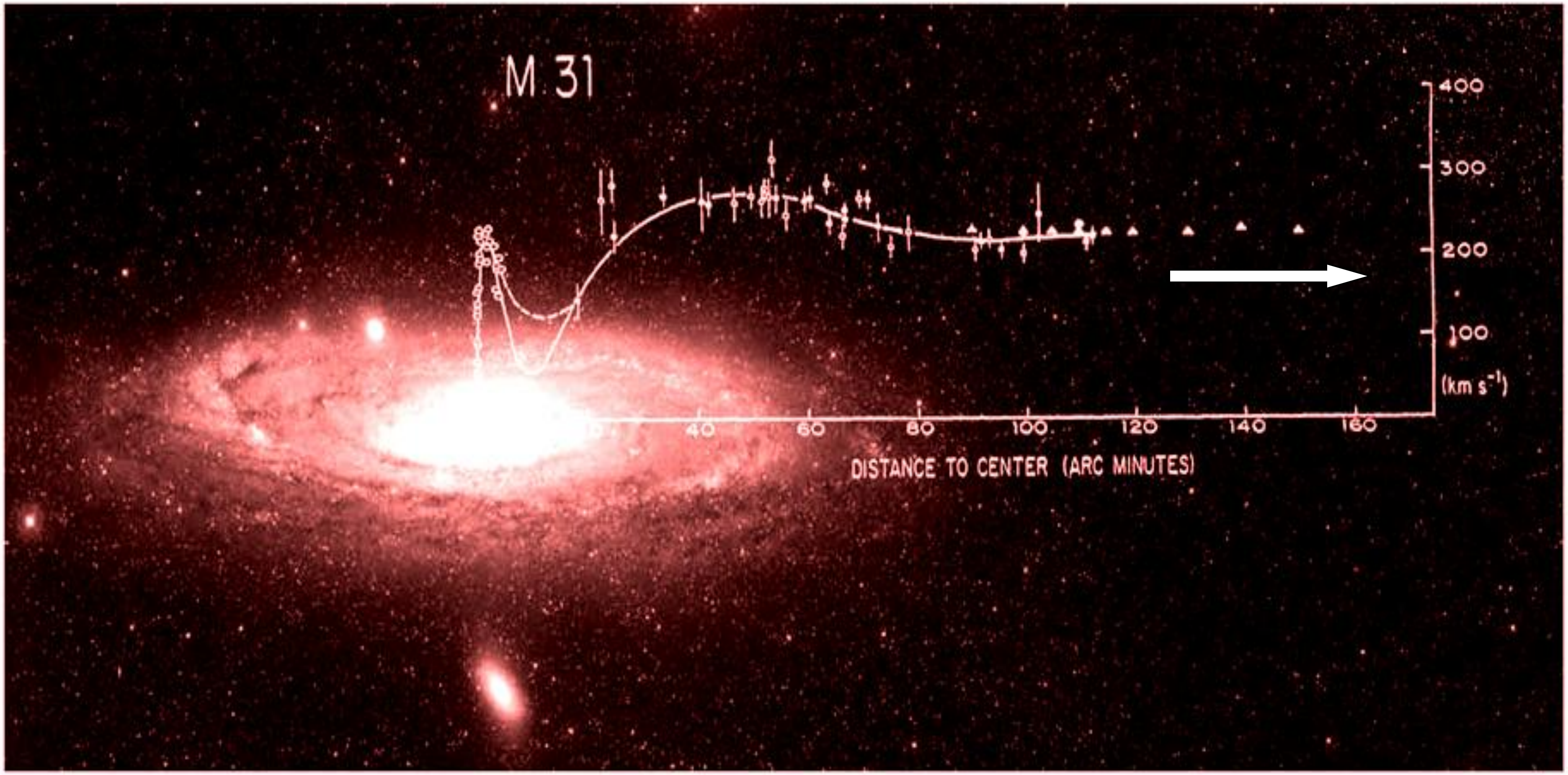
The problems of gravitating neutrino background were at first studied by
D.Brill and J.Wheeler
[Rev. Mod. Phys. **20**, 465 (1957)]
for the massless neutrino case.

Rotation curves and dark matter



Rotation curves of M31 galaxy according to optical (dots) and radio (triangles) data. The arrow shows the radial direction of expected slow (isothermal-type) decrease in density of gravitating neutrino DM background.

Dark matter models

- *Cold* Dark Matter
  - Carriers: WIMPs (Weakly Interacting Massive Particles, SUSY)
  - Mass scale: 100 GeV – 10 TeV
- *Warm* Dark Matter
  - Carriers: Neutralinos, etc.
  - Mass scale: 1 keV – 10 keV
- *Hot* Dark Matter
  - Carriers: Axions, Neutrinos
  - Mass scale: 10^{-6} eV – 10^{-1} eV
- *Tachyon* Dark Matter
  - Carriers: Tachyon Neutrinos
  - Mass scale: 10^{-3} eV – 1eV (10^{8} eV?-OPERA)

The necessity for tachyonic Dark Matter

- WIMPs
- Neutralinos
- Axions

→ HYPOTHETICAL

Bradyon neutrinos and antineutrinos

→ Observable, but give only 1% TM

$$(e^- e^+ \leftrightarrow \nu \bar{\nu})$$

Tachyon neutrinos and antineutrinos

→ Observable and can give the necessary 23% DM

Isothermal profile for DM

Nonlocal quasi-newtonian interaction

$$\Delta\varphi(\vec{r}) = 4\pi G\left[\rho_B(\vec{r}) + \tfrac{1}{4\pi\lambda}\int \tfrac{\rho_B(\vec{r}\,')}{|r-r'|^2}\,d\vec{r}\,'\right]$$

for the source function of type

$$\rho_B(\vec{r}) = M\delta(\vec{r}-\vec{r}_0)$$

yields the potential: $$\varphi(r) = -\frac{GM}{r} + \frac{GM}{\lambda}\ln\left(\frac{r}{\lambda}\right), \qquad \frac{GM}{\lambda} = v_0^2$$

to which corresponds an isothermal profile of DM

$$\rho_{DM}(r) = \rho_0 \frac{1}{(r/\lambda)^2}.$$

Such a profile is to be natural for the tachyon neutrinos background.

Isothermal profile for the neutrino Dark Matter

Isothermal profile of density is related to logarithmic potential which satisfies to axisymmetric solutions of Klein-Gordon and Helmholtz equations

$$(\Box \pm m^2)\Phi(r,t) = 0 \Longrightarrow (\Delta \pm m^2)\Phi(r) = 0$$

for the quasi-stationary tachyon neutrinos background to be represented by scalar conglomerate (superposition) of fields ν and $\overline{\nu}$.

DARK ENERGY + DARK MATTER

$$\phi = (\phi_+ + \phi_-)/\sqrt{2}$$

$$ds^2 = e^{-2\phi}dt^2 - e^{2\phi}a^2(\phi(t))(dr^2 + r^2 d\Omega^2)$$

$$e^{\pm 2\phi} \approx 1 \pm 2\phi$$

$$ds^2 = e^{-2GM/r}dt^2 - e^{2GM/r}\exp\{-|\Lambda|(t-t_0)^2\}(dr^2 + r^2 d\Omega^2)$$

$$\phi = \phi_{Newton}(r) + \Phi_{dm}(r)$$

$$L^{DM} = \tfrac{1}{2}[\nabla_\mu \Phi \nabla^\mu \Phi + m_\nu^2 \Phi^2]$$

$$\nabla_\mu \nabla^\mu \Phi - m_\nu^2 \Phi = 0$$

Mass scales for DE and DM

- **DE is a neutral composition of quasi-static electric fields generated by all fermions**

$$\phi \sim \phi^{+} + \phi^{-}$$

with mass scale of order $10^{-33} eV$

- **DM is the tachyon neutrino-antineutrino conglomerate** $\Phi = \Psi^{\dagger}\Psi = \nu^{2} + \overline{\nu}^{2}$

with mass scale in the range $(10^{-3} \div 1) eV$

Tachyonity principle:

No imaginary masses and negative energies!

Bradyons (v<c, c=1):

$$E = m/\sqrt{1-v^2}, \quad \vec{p} = m\vec{v}/\sqrt{1-v^2}$$

$$p_\mu p^\mu = E^2(v) - p^2(v) = m^2 \quad \Leftrightarrow \quad L^T g L = g$$

Tachyons (u>c, c=1):

$$E = m/\sqrt{u^2-1}, \quad \vec{p} = m\vec{v}/\sqrt{u^2-1}$$

1) $m^2 \to -m^2 \Leftrightarrow p_\mu p^\mu = E^2(u) - p^2(u) = -m^2$

2) $m^2 = -p_\mu p^\mu = p^2(u) - E^2(u) \Leftrightarrow \tilde{L}^T g \tilde{L} = -g$

$$\tilde{L} = ?$$

Principle of velocity inversion

Ansatz:

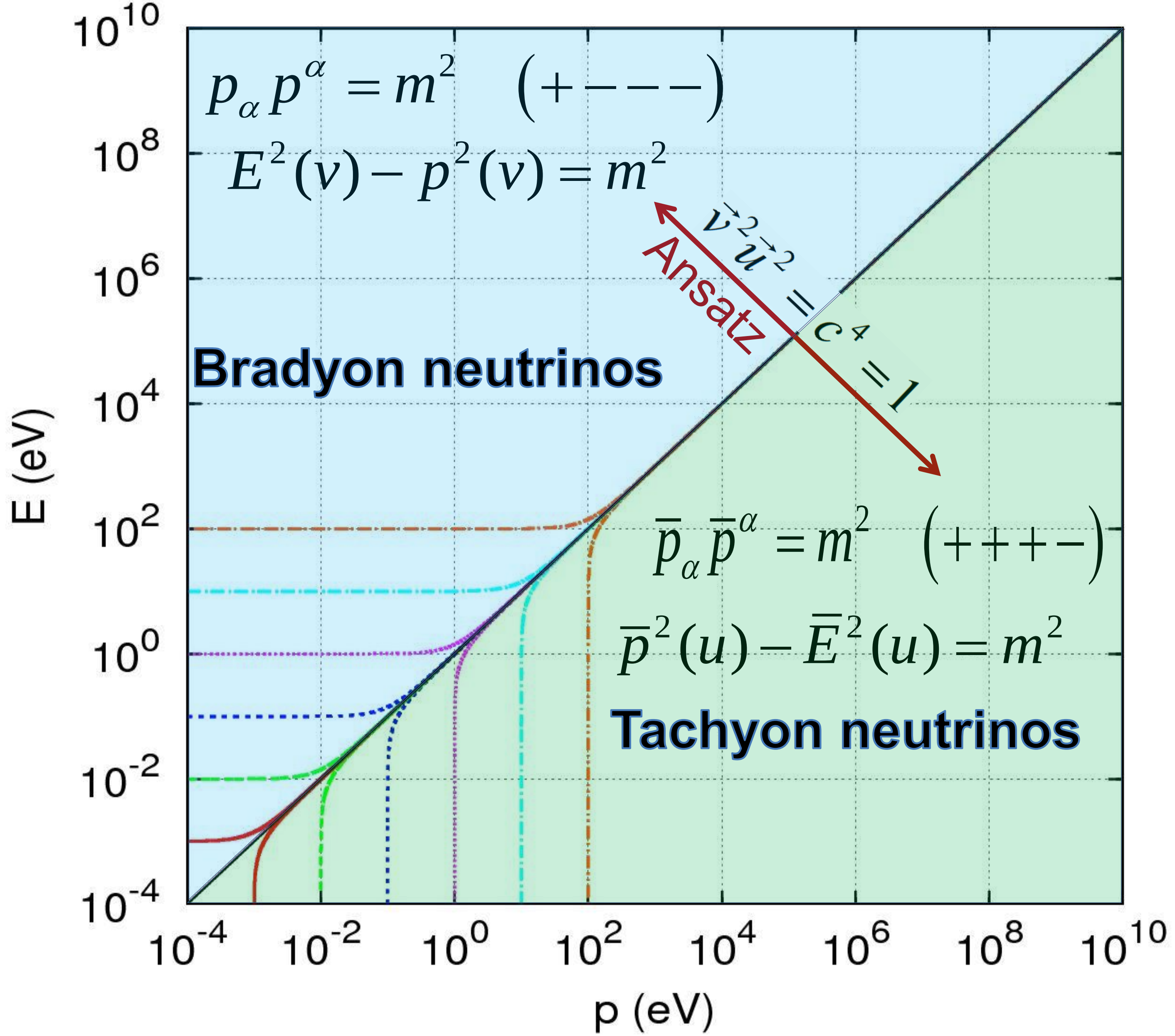
$$\begin{array}{|c|}\hline \vec{v}^{\,2}\vec{u}^{\,2} = c^4 = 1 \\ vu = c^2 = 1 \\ \hline\end{array} \Rightarrow \quad v = 1/u$$

$$p_\mu p^\mu = E^2(v) - p^2(v) = m^2$$

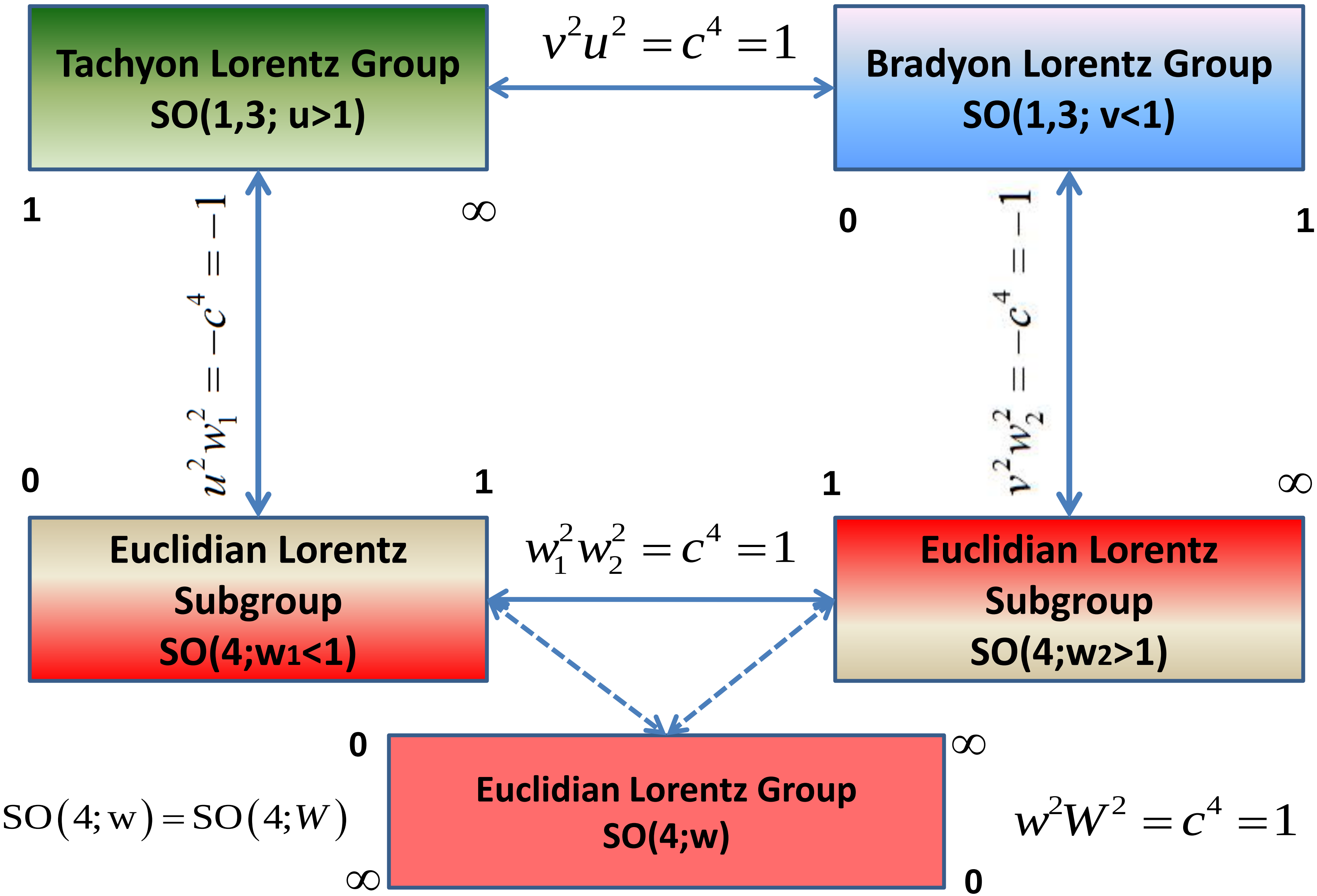
$$v = 1/u \;\Downarrow\Uparrow\; u = 1/v$$

$$\overline{p}_\mu \overline{p}^\mu = \overline{p}^2(u) - \overline{E}^2(u) = m^2$$

Dispersion relations for bradyons and tachyons



THE LORENTZ GROUPPOID



DISPERSION RELATIONS FOR THE LORENTZ GROUPPOID

$\gamma(u) = (u^2 - 1)^{-\frac{1}{2}}$

$$p^2(u) - E^2(u) = m^2$$
$$E = m\gamma(u),\ \vec{p} = m\vec{u}\gamma(u)$$

u = 1 u = ∞

$v^2 u^2 = c^4 = 1$

$\gamma(v) = (1 - v^2)^{-\frac{1}{2}}$

$$E^2(v) - p^2(v) = m^2$$
$$E = m\gamma(v),\ \vec{p} = m\vec{v}\gamma(v)$$

v = 0 v = 1

$u^2 w_1^2 = -c^4 = -1$

$v^2 w_2^2 = -c^4 = -1$

w₁ = 0 w₁ = 1

$$E^2(w_1) + p^2(w_1) = m^2$$

$\gamma(w_1) = (1 + w_1^2)^{-\frac{1}{2}}$

$w_1^2 w_2^2 = c^4 = 1$

w₂ = 1 w₂ = ∞

$$E^2(w_2) + p^2(w_2) = m^2$$

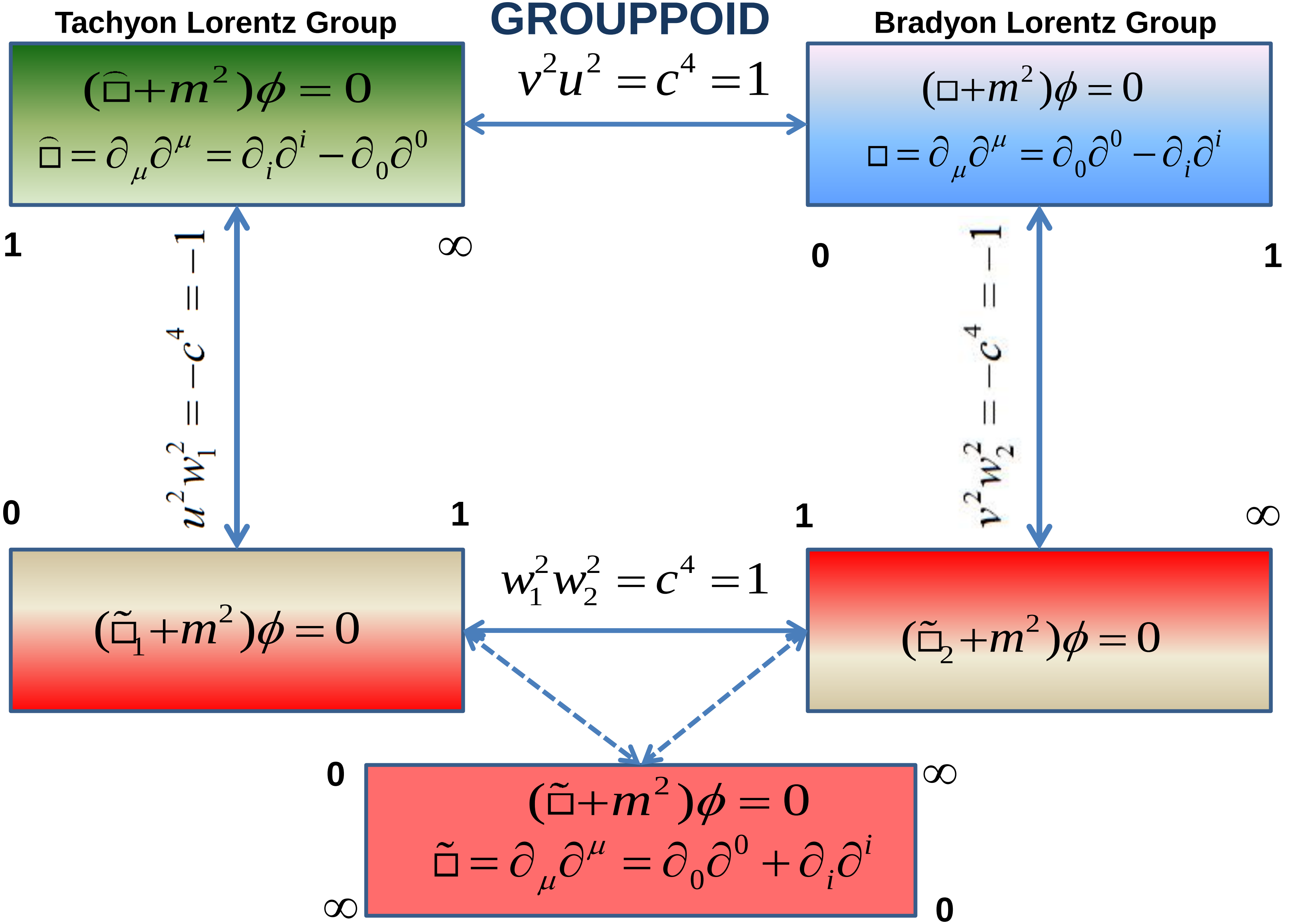
$\gamma(w_2) = (1 + w_2^2)^{-\frac{1}{2}}$

$$E^2(w) + p^2(w) = m^2$$
$$E = m\gamma(w),\ \vec{p} = m\vec{w}\gamma(w)$$

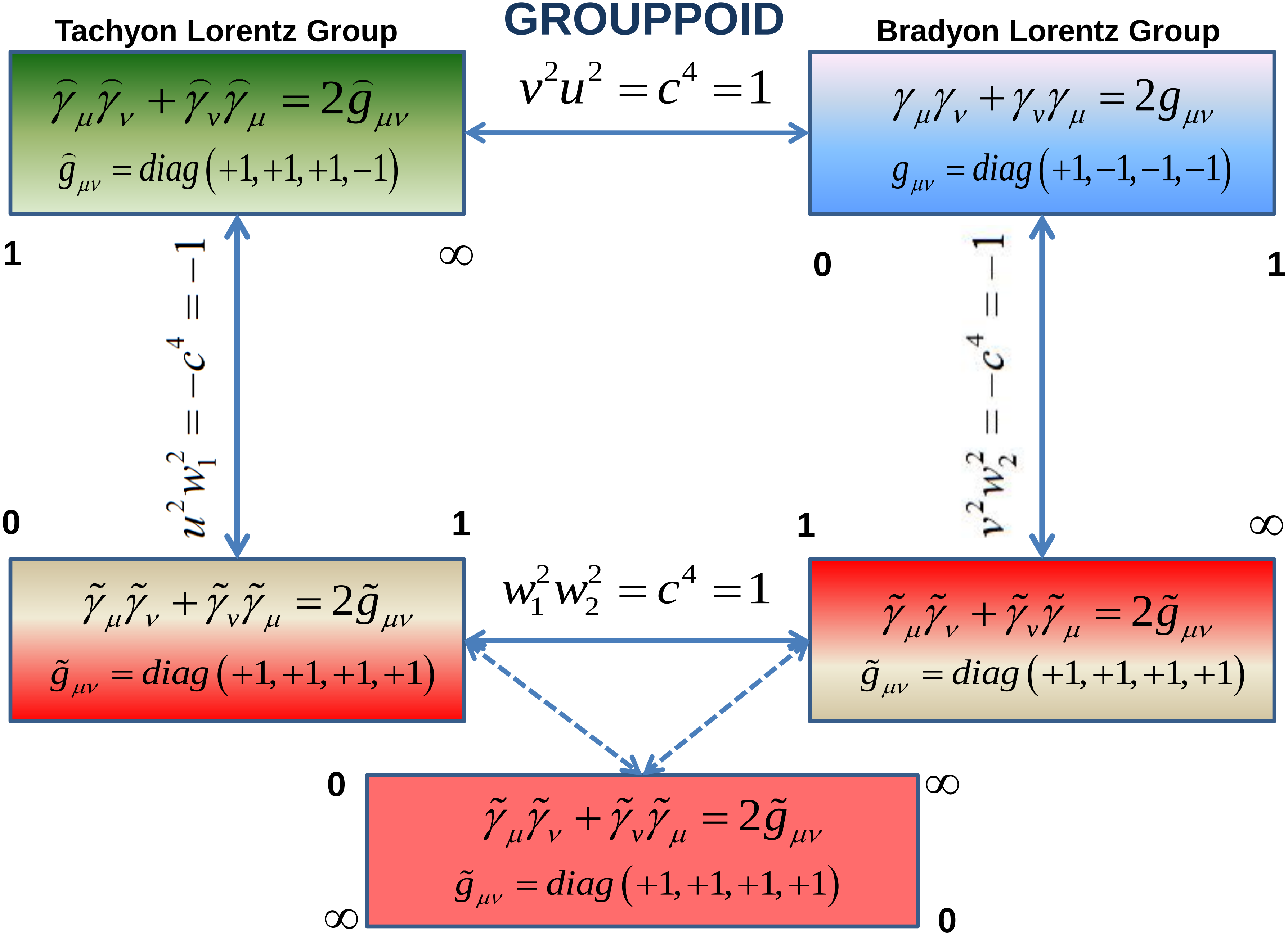
w = 0 w = ∞

$\gamma(w) = (1 + w^2)^{-\frac{1}{2}}$

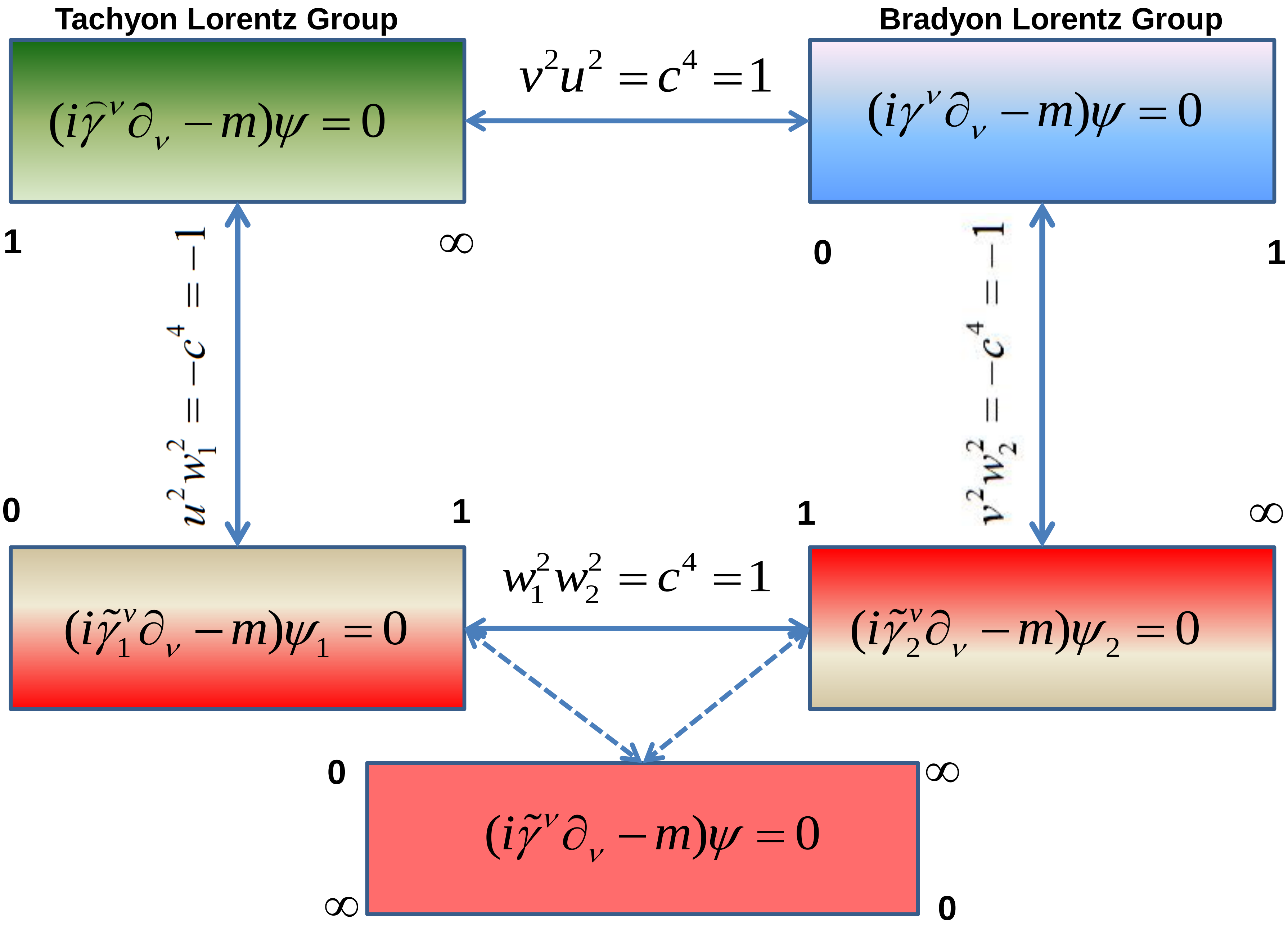
KLEIN-GORDON EQUATIONS FOR THE LORENTZ GROUPPOID



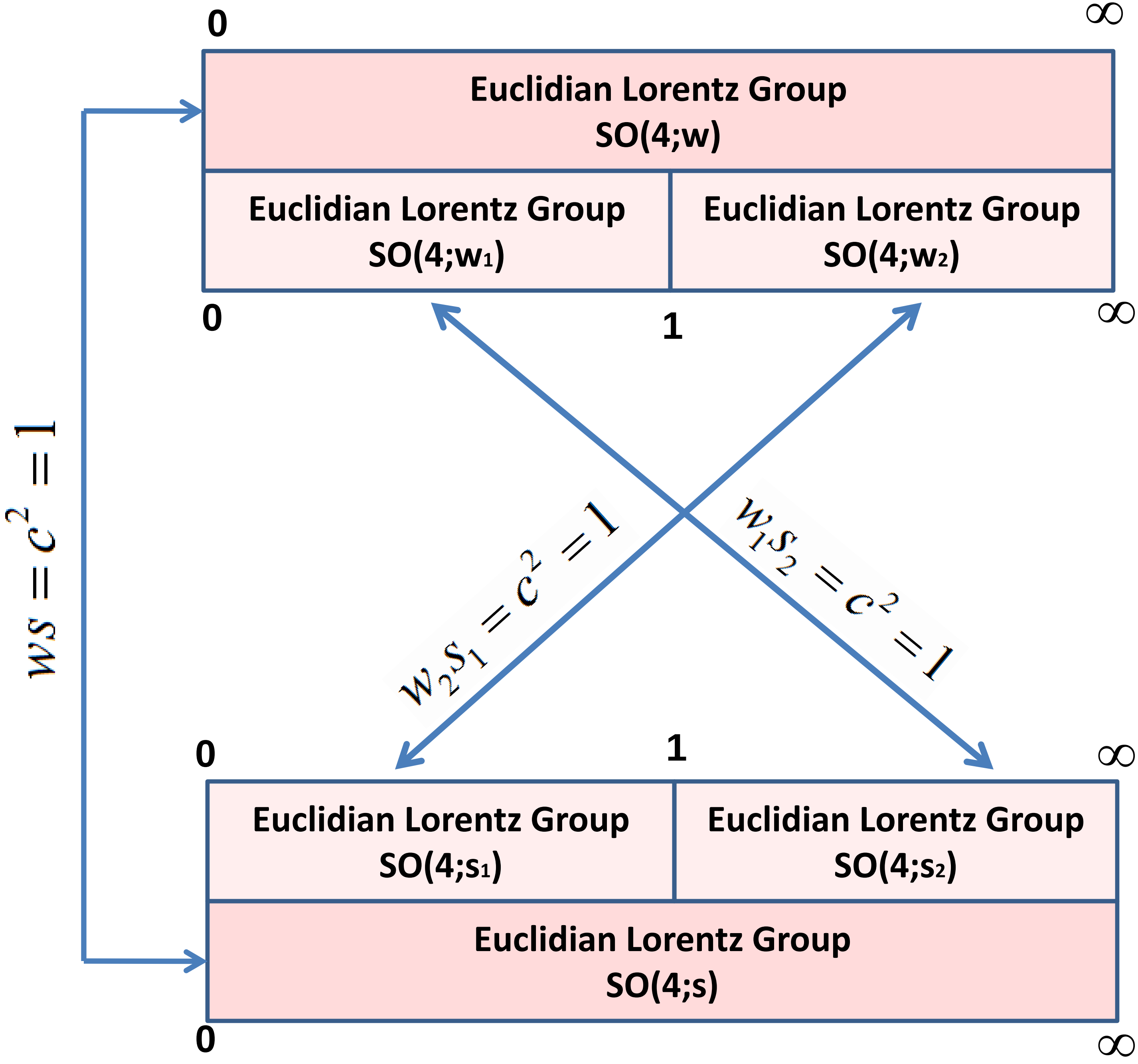
GRASSMANN ALGEBRAS FOR THE LORENTZ GROUPPOID



DIRAC EQUATIONS FOR THE LORENTZ GROUPPOID



THE EUCLIDIAN LORENTZ GROUP



On the tachyon Lagrangians

$$\Gamma = \gamma^0\gamma^5 = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \quad \psi = \begin{pmatrix} \psi_R \\ \psi_L \end{pmatrix} \quad \psi_R = \bar{\nu} \quad \psi_L = \nu$$

Jentshura's tachyon Dirac equation:

$$(i\gamma^\mu\partial_\mu - \gamma^5 m)\psi = 0 \quad \Downarrow$$

$$L = \bar{\psi}(i\gamma^\mu\partial_\mu - \gamma^5 m)\psi =$$
$$\psi^\dagger\gamma^0(i\gamma^\mu\partial_\mu - \gamma^5 m)\psi =$$
$$\psi^\dagger\gamma^0 i\not{\partial}\psi + \Gamma m\psi^\dagger\psi =$$
$$\bar{\psi}_L i\not{\partial}\psi_L + \bar{\psi}_R i\not{\partial}\psi_R +$$
$$\Gamma m(\psi_L^\dagger\psi_L + \psi_R^\dagger\psi_R)$$

Nsw tachyon Dirac equation:

$$(i\gamma^\mu\partial_\mu - \Gamma m)\psi = 0 \quad \Downarrow$$

$$L = \psi^\dagger(i\gamma^\mu\partial_\mu - \Gamma m)\psi =$$
$$\psi^\dagger i\not{\partial}\psi + \Gamma m\psi^\dagger\psi =$$
$$\psi^\dagger{}_L i\not{\partial}\psi_R + \psi^\dagger{}_R i\not{\partial}\psi_L +$$
$$\Gamma m(\psi_L^\dagger\psi_L + \psi_R^\dagger\psi_R)$$

On the tachyon Dirac Equation

$$(i\gamma^{\mu}\partial_{\mu} - \Gamma m)\psi = 0 \Rightarrow$$

$$(p_0 + \vec{\sigma}\vec{p} + m)\psi_R = 0$$

$$(p_0 - \vec{\sigma}\vec{p} - m)\psi_L = 0$$

The Dirac equation in terms of γ(old) and $\widehat{\gamma}$(new) matrices

Old: $$-\Gamma(i\gamma^{\mu}\partial_{\mu}-\Gamma m)\psi=0\Rightarrow$$

$$(-i\Gamma\gamma^{\mu}\partial_{\mu}-m)\psi=0$$

New: $$(i\widehat{\gamma}^{\mu}\partial_{\mu}-m)\psi=0$$

So: $$\widehat{\gamma}^{\mu}=-\Gamma\gamma^{\mu}$$

$$\Gamma=\gamma^{0}\gamma^{5}=\begin{pmatrix}0 & 1\\ -1 & 0\end{pmatrix},\Gamma^{2}=-1$$

Dark Matter as a conglomerate of free neutrino-antineutrino fields

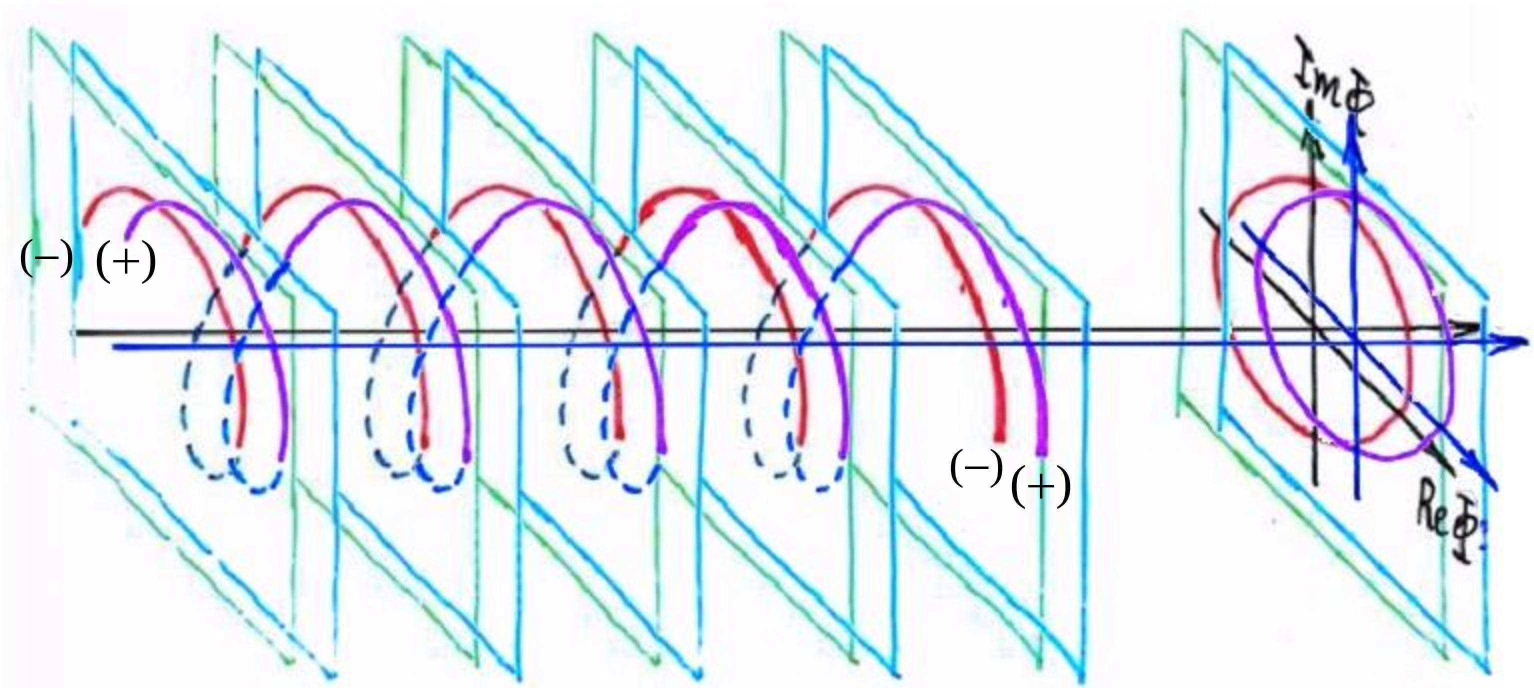
$$\Phi = \Psi^{\dagger}\Psi = \nu^2 + \overline{\nu}^2$$

$$\Psi = \nu + i\overline{\nu} \qquad \Psi^{\dagger} = \nu^{\dagger} - i\overline{\nu}^{\dagger}$$

$$\nu^2 = \nu^{\dagger}\nu \qquad \overline{\nu}^2 = \overline{\nu}^{\dagger}\nu$$

$$\Psi = \begin{pmatrix} i\psi_R \\ \psi_L \end{pmatrix} \qquad \begin{pmatrix} \psi_R = \overline{\nu} \\ \psi_L = \nu \end{pmatrix}$$

Neutrinos may be imagined as shock-vortexes propagating as boson-like (Dolgov) neutral particles



Propagation:

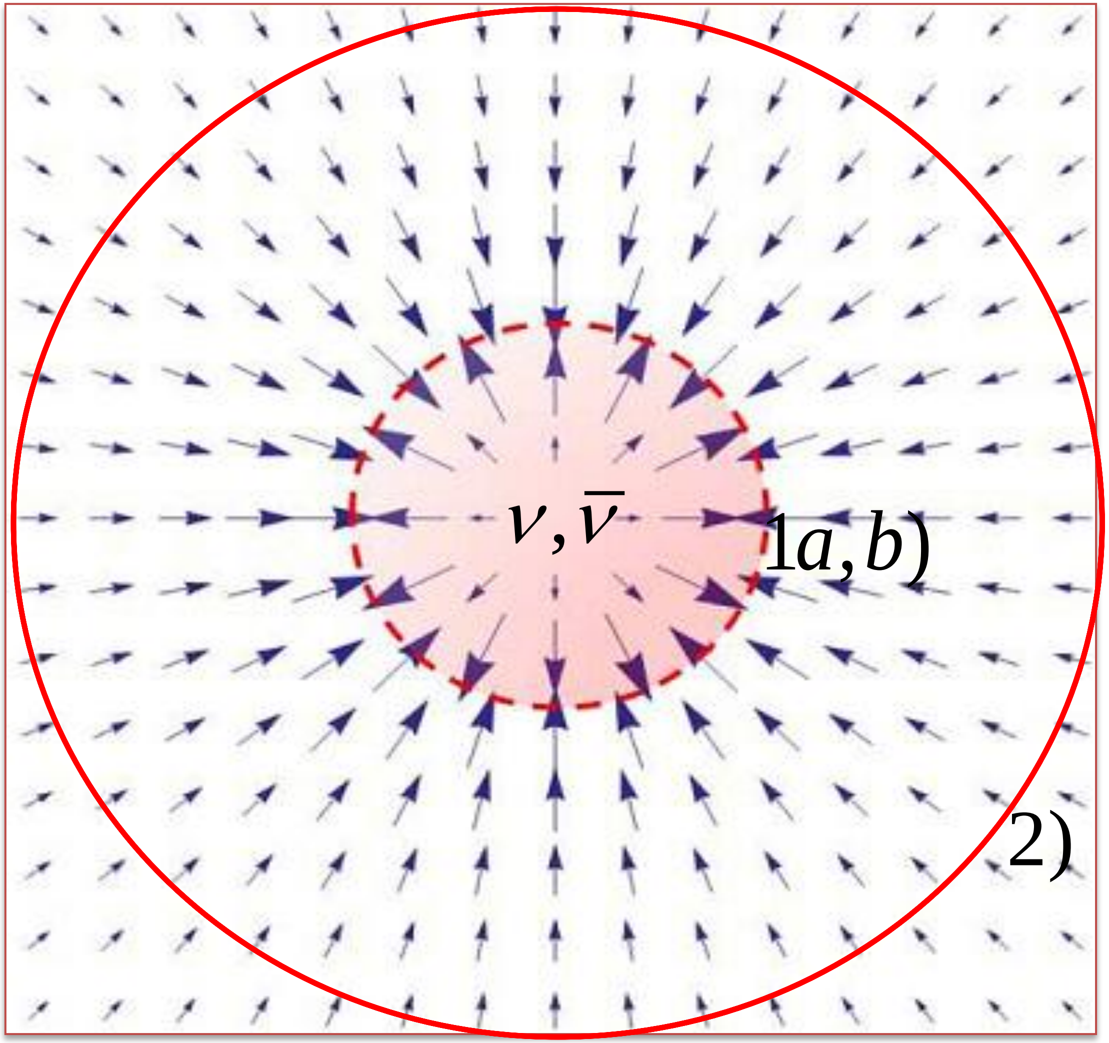
$$\psi = \psi^{(-)} + \alpha \psi^{(+)}$$

$$\alpha \approx 1 \quad (but < 1)$$

$$Majorana:$$

$$\psi_M = \psi + \psi^C$$

Two steps in tachyon neutrino anticollapse



$$W^+ + W^- \to \nu + \bar{\nu}$$
$$Z \to \nu + \bar{\nu}$$

$$e^- + e^+ \to \nu + \bar{\nu}$$

$$\Downarrow$$

$$1a)\nu + \bar{\nu} \to W^+ + W^-$$
$$1b)\nu + \bar{\nu} \to Z$$

$$2)\nu + \bar{\nu} \to e^- + e^+$$

Modified electrodynamics

Non-zero masses of effective neutral SF-carriers $m_\varphi \sim 10^{-33} eV$

may be generated by fields as basic component: $(\phi_- + i\phi_+)/\sqrt{2} = \phi$

So, the electric fields must obey by the same order masses $m_{\phi_\pm} \sim 10^{-33} eV$

This leads to inevitable modification of electrodynamics (not Proca's!):

$$L = -(\tfrac{1}{4} F_{\mu\nu} F^{\mu\nu} + A_\mu j^\mu) - \tfrac{1}{2}\mu^2 (A_\mu u^\mu)^2$$

with non-zero mass-factor $\mu^2 = -m_{(i)}^2, (i) = (+,-)$ **(tachyonity)**

being too negligible to be detected in experiment.

Now for free fields instead of $\Box A_\mu = 0$

we have as usual for photons $\Box A_j = 0,\ j = 1,2,3$,

but for tachyon scalar we get $(\Box - m_{(i)}^2) A_\mu u^\mu = 0$

or, in quasi-static limit, $(\Delta + m_{(i)}^2) A_\mu u^\mu = 0$.

So, the scalar fields (potentials) are singled out for all the preferred (for example, inertial) frames $\{u^\mu\}$ **:** $\phi_\pm = A_\mu u^\mu$

The modified SM?

Today the 125 GeV Higgs-like particle is known.

But is it the Higgs boson indeed?

If no Higgs at all to be,

what may replace the SSB?

$$L = -\tfrac{1}{4} G^{a}_{\mu\nu} G^{\mu\nu}_{a} + \tfrac{1}{2} [D_{\mu}(A_{\alpha} u^{\alpha})]^{a} [D^{\mu}(A_{\alpha} u^{\alpha})]_{a}$$

$$-\tfrac{1}{2} m_{\nu}^{2} (A^{a}_{\mu} u^{\mu})^{2} + \lambda (A^{a}_{\mu} u^{\mu})^{4} \qquad \Rightarrow$$

$$-\tfrac{1}{4} G^{a}_{\mu\nu} G^{\mu\nu}_{a} + \tfrac{1}{2} [D_{\mu}(A_{\nu} u^{\nu})]^{a} [D^{\mu}(A_{\nu} u^{\nu})]_{a}$$

$$+\exp\{-\tfrac{1}{2} m_{\nu}^{2} (A^{a}_{\mu} u^{\mu})^{2}\} - 1$$

References

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THANK YOU!