58(5): Spacetime Characteristics of the Whirlpool Galaxy

The velocity field of fluid spacetime needed for the formation of a whirlpool galaxy is:

$$\underline{v}_F = \frac{L_{Fz}}{m(X^2+Y^2)}\left(-Y\underline{i} + X\underline{j}\right) \quad -(1)$$

so

$$\underline{\nabla} \cdot \underline{v}_F = 0 \quad -(2)$$

i.e. it is a divergenceless velocity field.

From the Lorenz condition of spacetime:

$$\frac{\partial \Phi_F}{\partial t} + a_0^2 \, \underline{\nabla} \cdot \underline{v}_F = 0 \quad -(3)$$

it follows that

$$\frac{\partial \Phi_F}{\partial t} = 0 \quad -(4)$$

therefore

$$\Phi_F = h_F \quad -(5)$$

is independent of time, i.e. the spacetime potential or enthalpy is independent of time.

From the wave equation:

$$\square \Phi_F = \square h_F = 4\pi G \rho_m(\text{matter}) \quad -(6)$$

where

$$\square = \frac{1}{a_0^2}\frac{\partial^2}{\partial t^2} - \nabla^2 \quad -(7)$$

it follows from eq. (4) that:

2)

$$\nabla^2 \Phi_F = -4\pi G \rho_m(\text{matter}) \quad -(8)$$

The gravitational field of the whirlpool galaxy is:

$$\underline{g}(\text{matter}) = -\frac{L_{FZ}^2}{m^2 r_F^3}\, \underline{e}_r \quad -(9)$$

In spherical polar coordinates:

$$\underline{\nabla} \cdot \underline{g} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 g_r\right) \quad -(10)$$

$$= \left(\frac{L_{FZ}}{m r_F^2}\right)^2$$

So the spacetime change needed for a whirlpool galaxy is:

$$\boxed{q_F = \left(\frac{L_{FZ}}{m r_F^2}\right)^2} \quad -(11)$$

Using the equation:

$$\boxed{\begin{aligned}\rho_m(\text{matter}) &= \frac{1}{4\pi G}\left(\frac{L_{FZ}}{m r_F^2}\right)^2 \\ &= \frac{q_F}{4\pi G}\end{aligned}} \quad -(12)$$

gives an expression for the mass density of a whirlpool galaxy.

3) <u>Units Check</u>

The units of G are $m^3 s^{-2} kg^{-1}$ so it is seen that ρ_m (matter) has the correct units of $kgm\, m^{-3}$.

From eq. (12):

$$\boxed{\rho_m\,(\text{matter}) \xrightarrow[r_F \to 0]{} \infty} \quad - (13)$$

So a very large mass [density] exists at the centre of the galaxy, as observed experimentally.

From eqs. (8) and (12):

$$\nabla^2 \underline{\Phi}_F = -\left(\frac{L_{FZ}}{m r_F^2}\right)^2 \quad - (14)$$

So

$$\boxed{\underline{\Phi}_F = h_F = -\frac{1}{6}\left(\frac{L_{FZ}}{m}\right)^2 \frac{1}{r_F^2}} \quad - (15)$$

The spacetime enthalpy is greatest near the centre of the galaxy.

The force law from eq. (9) is:

$$\underline{F}\,(\text{matter}) = m g\,(\text{matter})$$

$$= -\frac{L_{FZ}^2}{m r_F^3}\, \underline{e}_r \quad - (16)$$

4) Using the Binet equation:

$$F(r) = -\frac{L^2}{mr^2}\left(\frac{1}{r} + \frac{d^2}{d\theta^2}\left(\frac{1}{r}\right)\right) \quad -(17)$$

the force law (16) corresponds to the hyperbolic spiral orbit:

$$\boxed{\frac{1}{r} = \frac{\theta}{r_0}} \quad -(18)$$

of the stars in a whirlpool galaxy.

Therefore the hyperbolic spiral orbit is due to a constant spacetime angular momentum field in fluid gravitation.

As in previous work the orbit (18) leads to the correct velocity curve of the whirlpool galaxy as follows.

In plane polar coordinates (r, θ), the velocity of a star is:

$$v^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2 \quad -(19)$$

$$= \left(\frac{d\theta}{dt}\right)^2\left(r^2 + \left(\frac{dr}{d\theta}\right)^2\right)$$

From eq. (18):
$$\left(\frac{dr}{d\theta}\right)^2 = \frac{r^4}{r_0^2} \quad -(20)$$

and from Lagrangian theory:

5)

$$\left(\frac{d\theta}{dt^2}\right) = \frac{L^2}{m^2 r^4} \quad (21)$$

where L is a constant of motion. So:

$$v^2 = \frac{L^2}{m^2}\left(\frac{1}{r^2} + \frac{1}{r_0^2}\right) \quad (22)$$

$$\xrightarrow[r \to \infty]{} \left(\frac{L}{m r_0^2}\right)^2 = \underline{\text{constant}}$$

as observed experimentally.

As r becomes infinite the velocity of the star becomes constant. In fluid gravitation this is due to a constant spacetime or vacuum or aether angular momentum.