358(3): Equations for the Velocity Field of Spacetime in Fluid Gravitation

Consider:

$$\underline{g}\,(\text{matter}) = -\frac{\partial \underline{v}_F}{\partial t} - \underline{\nabla} h_F \quad -(1)$$

and the Lorenz condition:

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

Here the subscript F denotes spacetime quantities. The enthalpy h_F is the potential of spacetime:

$$h_F = \Phi_F \quad -(3)$$

Eqs. (1) and (2) are two equations in two unknowns, $\underline{v}_F$ and h_F. So for a given $\underline{g}$ (matter), the fluid velocity field and enthalpy of spacetime may be found. As in previous work, Eq. (2) implies

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

where

$$\square = \frac{1}{a_0^2}\frac{\partial^2}{\partial t^2} - \nabla^2 \quad -(5)$$

There is also the equation:

$$\underline{g}\,(\text{matter}) = \left(\left(\underline{v}_F \cdot \underline{\nabla} \right) \underline{v}_F \right) (\text{spacetime}) \quad -(6)$$

2) For Newtonian gravitation:

$$\underline{g}\,(\text{matter}) = -\frac{MG}{r^2}\,\underline{e}_r \quad -(7)$$

where $\underline{e}_r$ is the radial unit vector. So:

$$\frac{MG}{r^2}\,\underline{e}_r = \frac{\partial \underline{v}_F}{\partial t} + \underline{\nabla}\, h_F \quad -(8)$$

and

$$\frac{\partial h_F}{\partial t} + a_0^2\, \underline{\nabla} \cdot \underline{v}_F = 0 \quad -(9)$$

where

$$\Box h_F = 4\pi G \rho_m(\text{matter}). \quad -(10)$$

There is also the equation:

$$\left(\left(\underline{v}_F \cdot \underline{\nabla}\right)\underline{v}_F\right)(\text{spacetime}) = -\frac{MG}{r^2}\,\underline{e}_r \quad -(11)$$

By definition:

$$\left(\underline{\nabla}\, h_F = \frac{1}{\rho}\,\underline{\nabla}\, \underline{P}\right)(\text{spacetime}) \quad -(12)$$

where ρ is the density and $\underline{P}$ the pressure of fluid spacetime.

In the simple case:

$$\underline{\nabla}\, \underline{P} = 0 \quad -(13)$$

i.e. a spacetime of constant pressure, eq. (1) reduces

) to:

$$-\frac{\partial \underline{v}_F}{\partial t} = -\frac{mG}{r^2}\underline{e}_r \quad -(14)$$

So

$$\frac{\partial \underline{v}_F}{\partial t} = \frac{mG}{r^2}\underline{e}_r \quad -(15)$$

and

$$\boxed{\underline{v}_F = \frac{mG}{r^2}\underline{e}_r \,\Delta t} \quad -(16)$$

The units of G are $m^3 s^{-2} kg^{-1}$ so $\underline{v}_F$ has the correct units of $m\,s^{-1}$.

If $\underline{v}_F$ is directed along $\underline{k}$ then:

$$v_{ZF} = \frac{mG}{Z^2}\Delta t \quad -(17)$$

and

$$\left(\underline{v}_F \cdot \underline{\nabla}\right)\underline{v}_F = v_{ZF}^2 \frac{\partial v_{ZF}}{\partial Z}\underline{k} \quad -(18)$$

It follows that:

$$\boxed{\frac{2mG}{Z^3}(\Delta t)^2 = 1} \quad -(19)$$

$-(20)$

Eq. (19) is the result of:

$$\underline{g}\,(\text{matter}) = -\frac{mG}{Z^2}\underline{k} = \left(-\frac{\partial \underline{v}_F}{\partial t} = \left(\underline{v}_F \cdot \underline{\nabla}\right)\underline{v}_F\right)$$

(spacetime)