Real dimension in the Newtonian simulation of disk-like pressure-free systems

S. Halayka*

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Abstract

This paper contains a short introduction to Newtonian gravitation. The main focus is on some C++ code.

1 Brute force: field line intersection density gradient

Regarding the holographic principle, where n is the gravitational field line count, and A_s is the Schwarzschild black hole event horizon area:

$$n = \frac{A_s k c^3}{4G\hbar \log 2}, \tag{1}$$

the Schwarzschild radius is:

$$r_s = \sqrt{\frac{A_s}{4\pi}} = \sqrt{\frac{nG\hbar \log 2}{kc^3\pi}}, \tag{2}$$

and the mass is:

$$M = \frac{c^2 r_s}{2G} = \sqrt{\frac{nc\hbar \log 2}{4Gk\pi}}. \tag{3}$$

Where R is some far distance from the centre of the gravitating body (e.g, $R \gg r_s$), β is the get intersecting line length function, and ϵ is some small value (e.g 10^{-5}), the gradient is:

$$\gamma = \frac{\beta(R+\epsilon) - \beta(R)}{\epsilon}. \tag{4}$$

The gradient strength is:

$$g = -\gamma\pi = \frac{n}{2R^3}. \tag{5}$$

The Newtonian acceleration a_{Newton} and velocity v_{Newton} are:

$$a_{Newton} = \frac{v^2_{Newton}}{R} = \sqrt{\frac{gGc\hbar \log 2}{2R^2 k\pi}}, \tag{6}$$

$$v_{Newton} = \sqrt{a_{Newton} R} = \sqrt[4]{\frac{gGRc\hbar \log 2}{2k\pi}}. \tag{7}$$

*sjhalayka@gmail.com

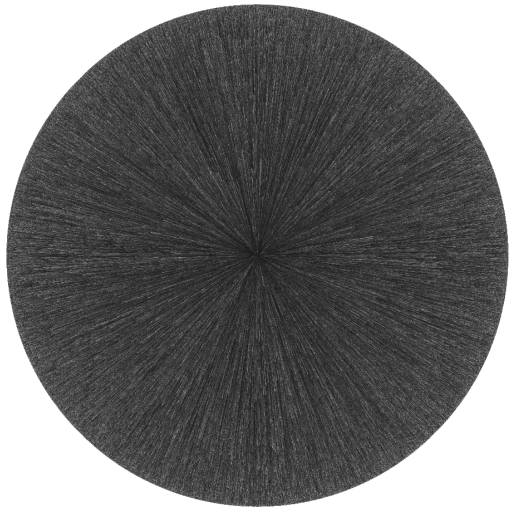

Figure 1: Where $D = 3$. The normals are isotropic.

From this we can get the Newtonian acceleration a_{flat} for a flat rotation curve of speed v_{flat}:

$$a_{flat} = \frac{v_{flat}^2}{R} = \frac{gRc\hbar \log 2}{2k\pi M}, \tag{8}$$

$$v_{flat} = \sqrt{a_{flat} R} = \sqrt{\frac{gR^2 c\hbar \log 2}{2k\pi M}}. \tag{9}$$

The ratio of the acceleration is

$$\frac{a_{flat}}{a_{Newton}} = R^d, \tag{10}$$

where $d = 3 - D$ stands for disk-like.

$$D = 3 - \frac{\log \frac{a_{flat}}{a_{Newton}}}{\log R}. \tag{11}$$

References

[1] Misner et al. Gravitation. (1970)

[2] ‘t Hooft. Dimensional reduction in quantum gravity. (1993)

[3] Susskind. The World as a Hologram. (1994)

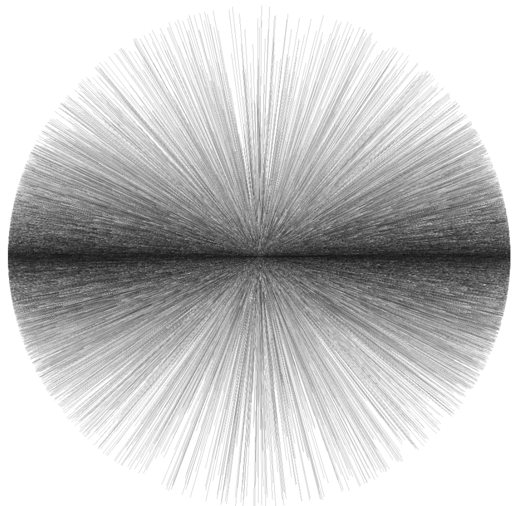

Figure 2: Where $D = 2.1$. The normals are increasingly anisotropic.

Figure 3: Where $D = 2.001$. The normals are anisotropic.

Figure 4: Where $D = 3$. This figure shows an axis-aligned bounding box and an isotropic emitter, looking from above. The bounding box is filled with the intersecting line segments.