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

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Abstract

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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} is:

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

The Newtonian acceleration a_{flat} for a flat rotation curve is:

$$a_{flat} = \frac{v^2_{flat}}{R} = \frac{gRc\hbar \log 2}{2k\pi M}. \tag{7}$$

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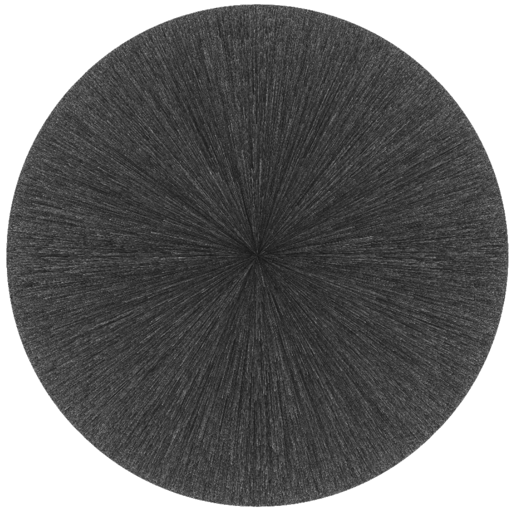

Figure 1: Where $D = 3$. The normals are isotropic.

The ratio of the acceleration is

$$\frac{a_{flat}}{a_{Newton}} = R^d, \tag{8}$$

where $d = 3 - D$ stands for disk-like, and the dimension of the gravitation field is:

$$D = 3 - \frac{\log \frac{a_{flat}}{a_{Newton}}}{\log R} = 3 - \frac{\log \frac{v^2_{flat}}{v^2_{Newton}}}{\log R}. \tag{9}$$

```
#include <cmath>
#include <iostream>
using namespace std;

const double G = 6.67430e-11;
const double c = 299792458;
const double c2 = c * c;
const double c3 = c * c * c;
const double pi = 4.0 * atan(1.0);
const double h = 6.62607015e-34;
const double hbar = h / (2.0 * pi);
const double k = 1.380649e-23;

int main(void)
{
        double M = 1e41;

        double r_s = 2 * G * M / c2;
        double A_s = 4 * pi * r_s * r_s;
        double n = A_s * k * c3 / (4 * G * hbar * log(2.0));

        double R = 3e20;
        double g = n / (2 * R * R * R);

        double a_Newton = sqrt((g * G * c * hbar * log(2.0))/(2 * R*R * k * pi));
```

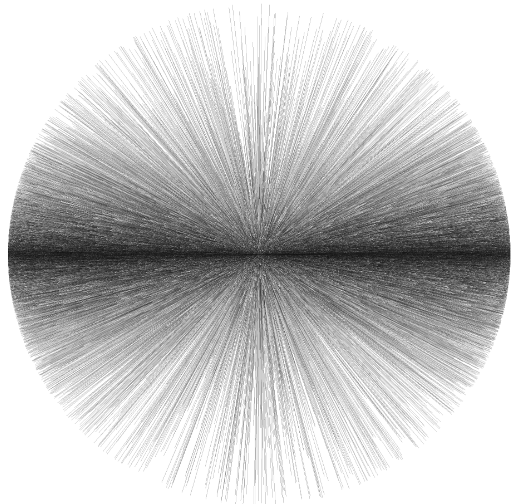

Figure 2: Where $D = 2.1$. The normals are increasingly anisotropic.

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.

```
        double a_flat = pow(220000, 2.0) / R;

        double v_Newton = sqrt(a_Newton * R);
        double v_flat = 220000;

        double D = 3.0 - log(a_flat / a_Newton) / log(R);
        double D_ = 3.0 - log(pow(v_flat, 2.0) / pow(v_Newton, 2.0)) / log(R);

        cout << D << endl;
        cout << D_ << endl;

        return 0;
}
```

References

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

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

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