On particle emission and absorption

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Abstract

Anisotropic emission of photons is considered. It is found that the interaction strength increases as the photon emission goes from spherical, to circular, to beam-like.

1 Dimensional reduction of the electromagnetic field

Consider an isotropic photon emitter at the origin. Also, consider a sphere-shaped absorber at position $(0, 100, 0)$, with a radius of 1.

Numerically, it is found that the inverse normalized interaction strength is 41152.3. That is, when the photon emission goes from spherical (e.g. perfectly isotropic) to beam-like (e.g. perfectly anisotropic), the interaction strength increases by a factor of 41152.3. See Fig 1. Similarly, when the photon emission is circular, the inverse normalized interaction strength is 315.259. See Fig 2. Of course, the interaction strength varies for various absorber positions and radii. Finally, when the photon emission is beam-like, the inverse normalized interaction strength is 1 (by definition). See Fig 3.

Altogether, these results are not surprising; it is all about the simple counting of the ray-sphere (e.g. photon-absorber) intersections. The only assumption is that the spectrum (e.g. temperature) can be at least conserved (e.g. $dT/dt \geq 0$) as the photon emitter goes from spherical, to circular, to beam-like. It is otherwise axiomatic: anisotropic photon emitters increase in interaction strength.

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2 Dimensional reduction of the gravitational field

What we really need to know is: can matter be coaxed into becoming an anisotropic graviton emitter? Do we already see this in the Universe? Is this the origin of the so-called dark matter in large-scale, gravitationally-bound systems?

3 Discussion

See Fig 4 for the main code.

The full C++ code is at `https://github.com/sjhalayka/particle`

Of course, for distances much larger than 100, it is possible to analytically obtain the inverse normalized interaction strength for a spherical emitter

$$I = \frac{4d^2}{r^2}, \tag{1}$$

where d is the absorber distance from the origin, and r is the absorber radius. For a circular emitter, the corresponding equation is

$$I = \frac{\pi d}{r}. \tag{2}$$

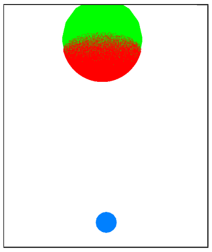

Figure 1: Blue spherical emitter at $(0, 0, 0)$. Green absorber at $(0, 4, 0)$. Ray-sphere intersection locations are coloured in red. A relatively low number of the photons emitted are absorbed. Note that the interaction strength is isotropic.

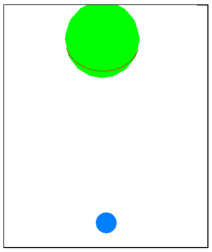

Figure 2: Blue circular emitter at $(0, 0, 0)$. Green absorber at $(0, 4, 0)$. Ray-sphere intersection locations are coloured in red. A relatively high number of the photons emitted are absorbed. Note that the interaction strength orthogonal to the circle's plane reduces as the photon emitter goes from spherical to circular.

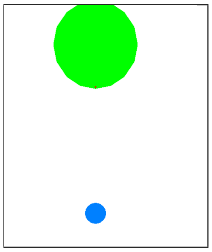

Figure 3: Blue beam emitter at $(0, 0, 0)$. Green absorber at $(0, 4, 0)$. Ray-sphere intersection location is coloured in red. 100% of the photons emitted are absorbed. Note that the interaction strength for all angles other than head-on reduces as the photon emitter goes from spherical to beam-like.

```
for (size_t i = 0; i < num_rays; i++)
{
    double u = rand() / static_cast<double>(RAND_MAX);
    double v = rand() / static_cast<double>(RAND_MAX);

    double theta = 2 * pi * u;
    double phi = acos(2 * v - 1.0);

    vector_3 pos;

    if (mode == sphere_mode)
    {
        // get pseudorandom vector on unit sphere
        // 3D
        pos.x = cos(theta) * sin(phi);
        pos.y = sin(theta) * sin(phi);
        pos.z = cos(phi);
    }
    else if (mode == circle_mode)
    {
        // get pseudorandom vector on unit circle
        // 2D
        pos.x = cos(theta);
        pos.y = sin(theta);
        pos.z = 0;
    }
    else if (mode == beam_mode)
    {
        // 1D
        pos.x = 0;
        pos.y = 1;
        pos.z = 0;
    }

    //ray_dirs.push_back(pos);

    float t = 0;

    if (line_sphere_intersect(
        vec3(0, 0, 0),
        vec3(pos.x, pos.y, pos.z),
        vec3(test_particle_pos.x, test_particle_pos.y, test_particle_pos.z),
        test_particle_radius,
        t))
    {
        //intersection_positions.push_back(ray_dirs[i] * t);
        intersection_count++;
    }
}
```

Figure 4: Normalized interaction strength = intersection count / number of rays. Inverse normalized interaction strength = 1.0 / normalized interaction strength. In this paper, number of rays is $10,000,000$.