Gravity Between Stars on a Galaxial Scale

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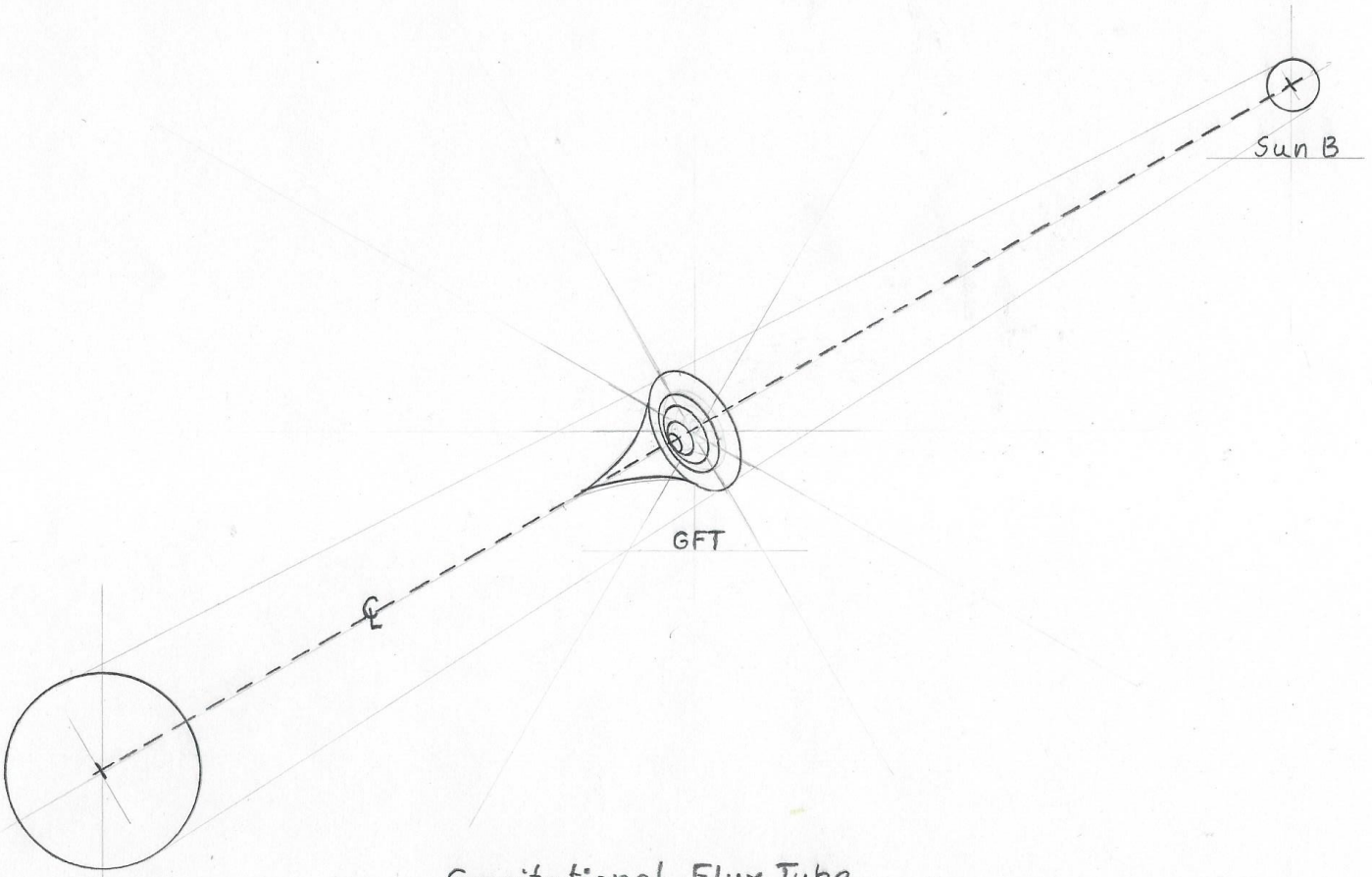
Abstract:

This paper tries to present a mechanism for Modified Newtonian Dynamics.

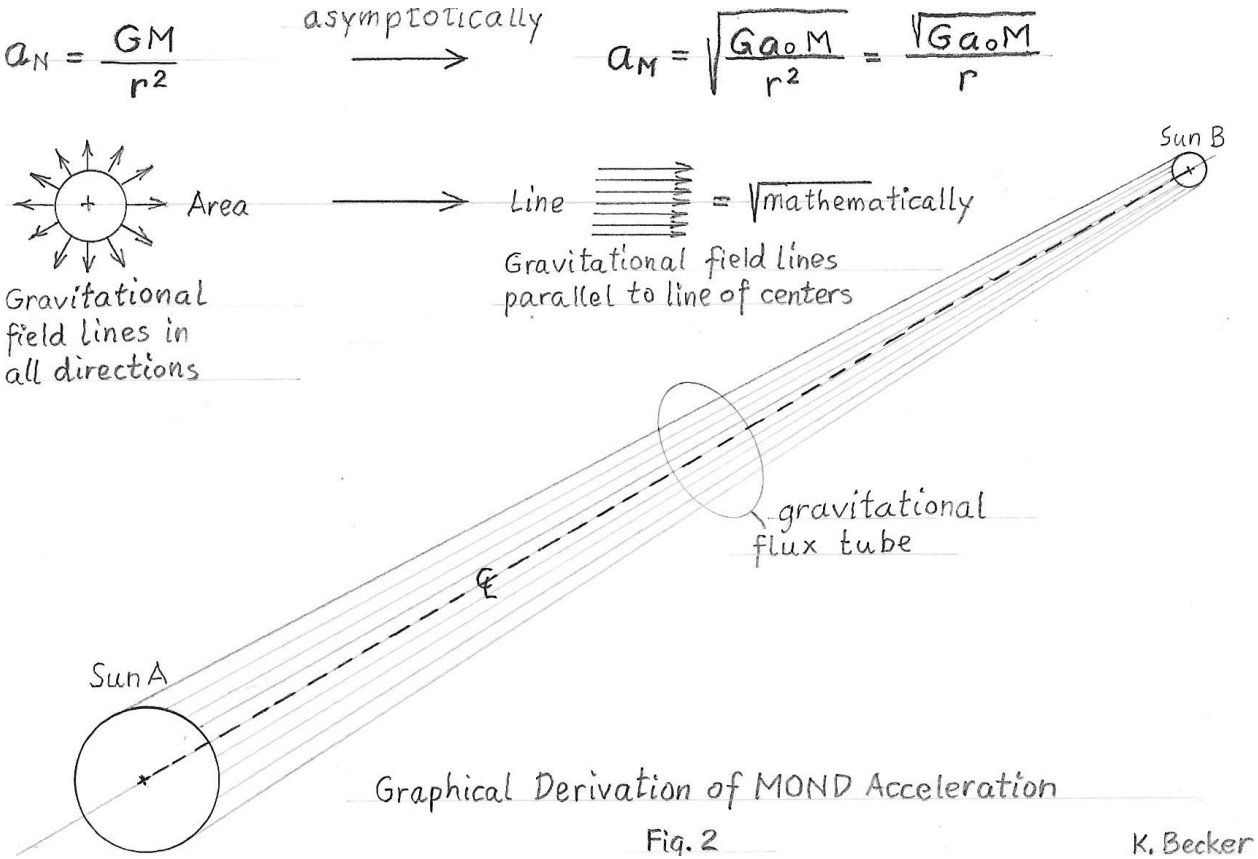
The gravitational effect, believed to be caused by dark matter, is due to the self-interaction of two gravitational fields around the center line between any two stars. This self-interaction results in increased radial compression of spacetime toward the center line. As will be shown below, it will result in a very slight increase in gravity between all stars at stellar distances. We know that at interstellar distances, Newtonian gravity is too weak to hold our galaxy together, thus the invention of a halo of dark matter. Very narrow tubes between all stars are holding the Milky Way galaxy together due to two effects: One is that its gravitational acceleration, as empirically estimated by Modified Newtonian Dynamics, by M. Milgrom, **decreases only with distance,** not with distance squared, as Newtonian gravity does. Ref. 1 The other one is, there are **hundreds of trillions of these gravitational flux tubes** between the hundreds of billions of stars in our galaxy. A gravitational flux tube can be compared to a bungee tube tow rope used by water skiers, which is always under tension.

By using gravitational flux tubes to mentally create models of groups of stars in the Milky Way galaxy, an unusual structure arises. A network about 5,000 flux tubes (GFT) keeps about 100 stars **together and apart.** (Of course, Newtonian gravity is keeping binary star systems together.) The flux tube structure will continue throughout the galaxy. This huge structure will be anchored by the black hole, Sagittarius A*, at the center of the galaxy, and will be balanced by GFT structures on the other side.

The GFT structure of stars will tend to rotate together, however there are other influences, such as densities of stars, that will modify its effect. How will the GFT structure affect stellar rotation curves and differential rotations of stars in barred spiral galaxies? What do astronomical observations show us? GFT structure and other hypotheses are discussed at the end of this paper.



Gravitational Flux Tube
Fig. 1



Graphical Derivation of MOND Acceleration

Fig. 2

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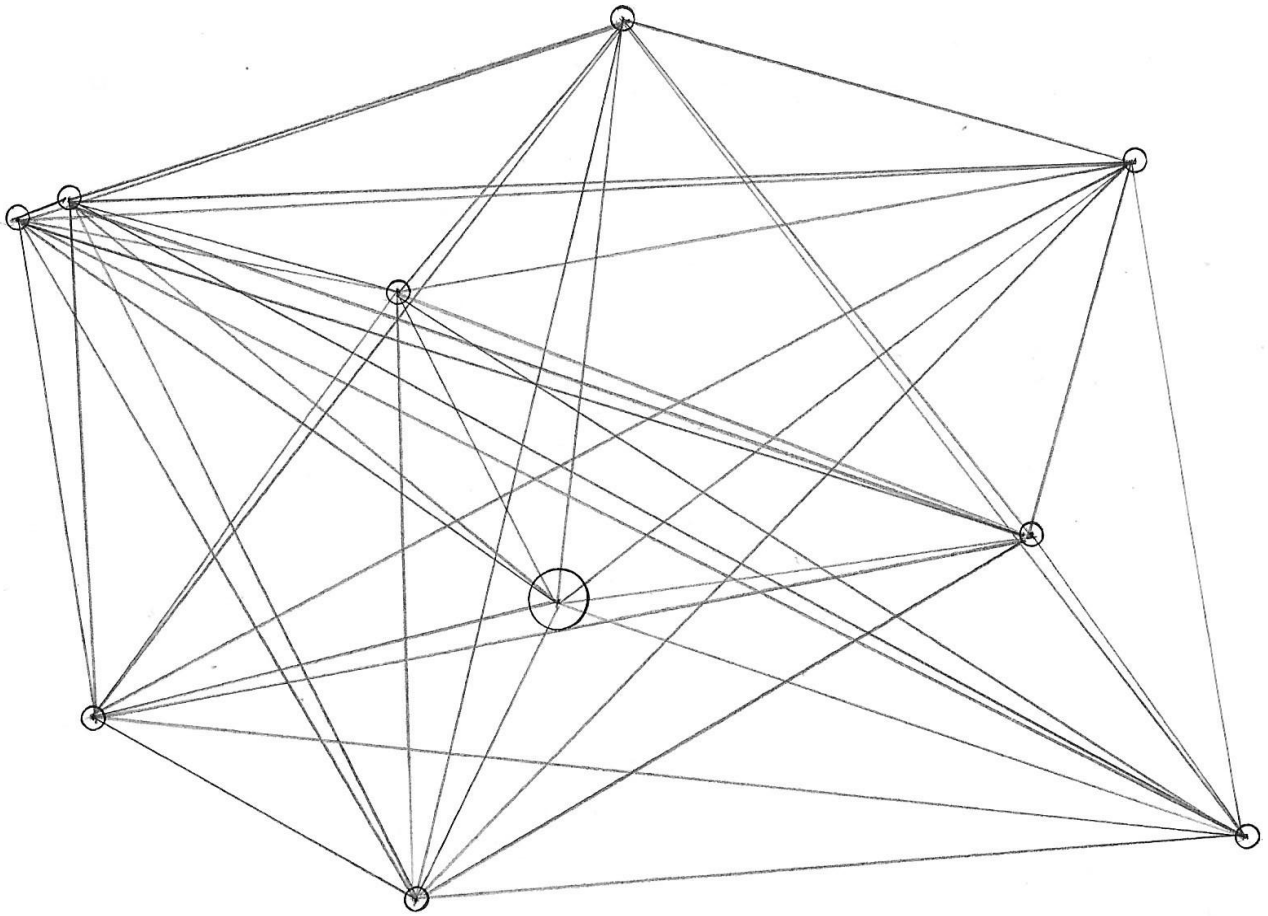

Gravitational Flux Tube Network betwen 10 Stars

Fig. 3

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Newton's Formula of Universal Gravitation is Incomplete

Newton's equation of Universal Gravitation needs to be modified, since it does not correctly predict the orbital velocities of stars in the Milky Way galaxy. Newton's equation of Universal Gravitation does not include the effects of gravitational self-interaction. See Fig. 2

$$a_g = \frac{GM}{r^2} + \frac{\sqrt{Ga_0M}}{r} \qquad \text{[E1]}$$

There are papers on arXiv.org and viXra.org describing other physical processes that result in additional gravity at the scale of galaxies and larger. MOND, Modified Newtonian Dynamics, by Mordecai Milgrom, was the first of such papers. Ref. 1. Professor Alexandre Deur, of the University of Virginia, has written papers comparing the mathematics of the self-interaction of the gravitational field to the self-interaction of the field within hadrons, protons and neutrons. Ref. 5

The second term on the right of equation [E] is Modified Newtonian Dynamics. A new constant a_0, estimated by Milgrom to be about 1.2E-10 m/s^2, to fit data of the rotation curves of stars in very weak gravitational fields. Ref. 1

Spreadsheet #1					
Distances between two stars in light years - ly	**r is distance in km**	**Description of Location**	$a_N = \frac{GM}{r^2}$	$a_M = \frac{\sqrt{Ga_0M}}{r}$	$a_T = a_N + a_M$
7.38E-06	6.98E+07	Mercury	2.72E-02	1.82E-06	2.72E-02
1.00E-05	9.46E+07		1.48E-02	1.35E-06	1.48E-02
1.58E-05	1.50E+08	Earth	5.93E-03	8.51E-07	5.93E-03
1.00E-04	9.46E+08		1.48E-04	1.35E-07	1.48E-04
1.52E-04	1.43E+09	Saturn	6.45E-05	8.87E-08	6.46E-05
4.74E-04	4.48E+09	Neptune	6.61E-06	2.84E-08	6.64E-06
1.00E-03	9.46E+09		1.48E-06	1.35E-08	1.50E-06
1.00E-02	9.46E+10		1.48E-08	1.35E-09	1.62E-08
1.00E-01	9.46E+11		1.48E-10	1.35E-10	2.83E-10
1.00E+00	9.46E+12		1.48E-12	1.35E-11	1.49E-11
4.34E+00	4.11E+13	Alpha Centauri A	7.86E-14	3.10E-12	3.18E-12
8.60E+00	8.14E+13	Sirius	2.01E-14	1.56E-12	1.58E-12
1.00E+01	9.46E+13		1.48E-14	1.35E-12	1.36E-12
1.70E+01	1.61E+14	Altair	5.13E-15	7.91E-13	7.96E-13
1.00E+02	9.46E+14		1.48E-16	1.35E-13	1.35E-13
5.48E+02	5.18E+15	Betelgeuse	4.94E-18	2.45E-14	2.46E-14
1.00E+03	9.46E+15		1.48E-18	1.35E-14	1.35E-14

1.00E+04	9.46E+16		1.48E-20	1.35E-15	1.35E-15
2.67E+04	2.52E+17	Distance to Sagittarius A*	2.09E-21	5.04E-16	5.04E-16
1.00E+05	9.46E+17		1.48E-22	1.35E-16	1.35E-16
1.00E+06	9.46E+18	Radius of Milky Way	1.48E-24	1.35E-17	1.35E-17
2.50E+06	2.37E+19	Andromeda Galaxy	2.37E-25	5.38E-18	5.38E-18
1.00E+07	9.46E+19		1.48E-26	1.35E-18	1.35E-18

Constants	**Symbol / Units**	**Description**
9.46E+15	ly in m	distance light travels in one year
6.67E-11	G in $m^3\ kg^{-1}\ s^{-2}$	universal gravitational constant
1.99E+30	M_{SUN} in kg	Mass of a star like our Sun
1.22E-10	$a_0 = m/s^2$	new constant estimated by M. Milgrom

Ref. 2 Wikipedia

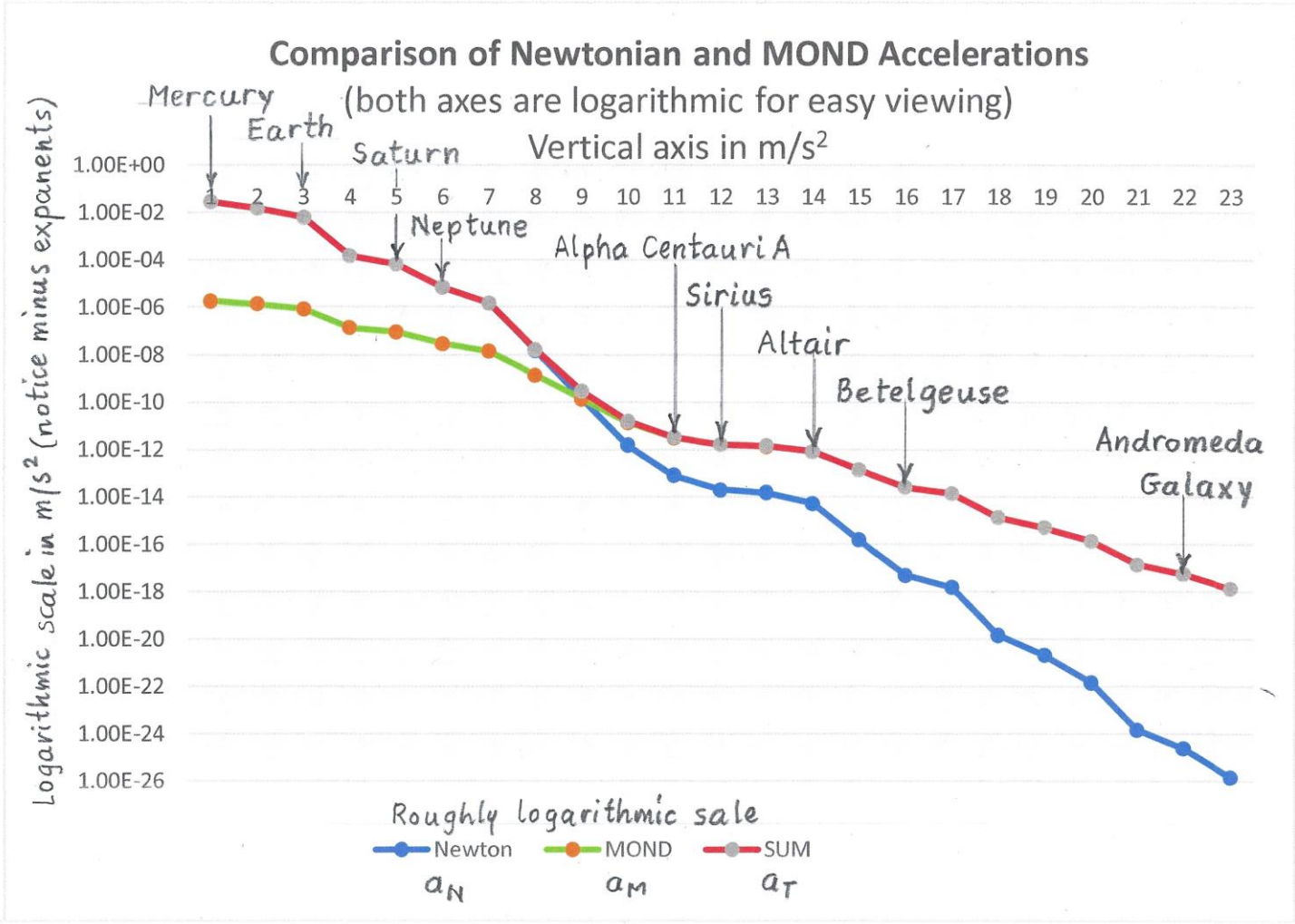

Comparison of Newtonian and MOND Accelerations
(both axes are logarithmic for easy viewing)
Vertical axis in m/s²
Logarithmic scale in m/s² (notice minus expanents)
1.00E+00
1.00E-02
1.00E-04
1.00E-06
1.00E-08
1.00E-10
1.00E-12
1.00E-14
1.00E-16
1.00E-18
1.00E-20
1.00E-22
1.00E-24
1.00E-26
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Mercury
Earth
Saturn
Neptune
Alpha Centauri A
Sirius
Altair
Betelgeuse
Andromeda Galaxy
Roughly logarithmic sale
Newton
MOND
SUM
a_N
a_M
a_T

Chart #1

How could gravity be increased by gravitational self-interaction?

According to General Relativity, gravity is the curvature of space-time. Around massive objects, such as stars, space-time is greatly bent. Gravitons are interchanged at the baryonic matter of the star. There is a geometric spherical symmetry around any star.

Where could gravitational fields interact? Where else are there geometric symmetries? There is a radial axial symmetry around and along the line of centers between any two stars. See Fig. 1 and 2. A gravitation field surrounds any stars and this field moves with the star. Along the line of centers, the two fields form an anti-parallel space-time. These fields will bend spacetime towards the line of centers. The stars must be moving away or towards each other. The result of bending the geodesics toward the centerline will be to increase the number gravitons being exchanged at the stars. How much will this radial curvature along the line of centers increase gravity? By the right most term of equation [E1], $\frac{\sqrt{Ga_0M}}{r}$, which is Modified Newtonian Dynamics. See Spreadsheet #1 and Ref. 1. **This increased gravitational beam might be called a gravitational flux tube, GFT.** See Fig. 1 and 2. There are papers, that discuss anti-parallel streams of energy, using equations of general relativity, which show that there is a very, very small bending of spacetime of two anti-parallel laser beams. Ref. 4

The center line between two stars is not a Euclidian straight line but a straight line taking the motion of the two stars, the speed of light, and the laws of general relativity into account. As two stars move relatively to each other, their gravitational fields move with the stars. There is energy flowing in anti-parallel streams along the center line.

I believe that space-time may also have entropy, with space-time around stars having lower entropy, more ordered, than in deep space between galaxies, where there are many more micro-states and space-time is expanding. A very narrow tube of space-time between two stars, also has a slightly lower entropy, since it is ordered radially around this line.

To greatly amplify the total effect of gravitational flux tubes, the astronomically huge number of GFTs must be taken into account. With n=100 billion stars in the

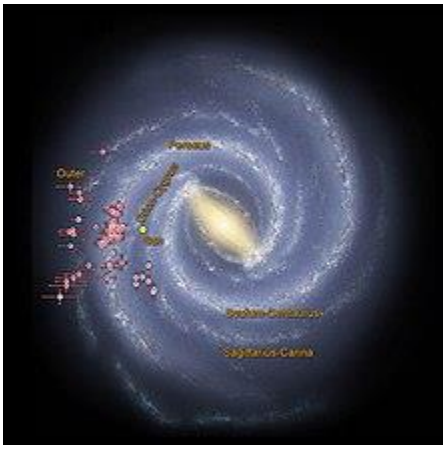
Milky Way galaxy and each one interacting with each other, equal to (n-1)*(n/2), which is about ½*n^2. The additional effect on gravity will be huge, astronomically huge. Granted many stars are on the other side of Sagittarius*A and will interact with the black hole. Many stars will be too far away and add little to the gravitational cohesions of our galaxy.

By looking at data of spreadsheet #1 and curves of chart #1, it can be easily seen, that **at stellar distances only MOND values determine gravity at galactic distances**.

The are probably no GFT between two dispersed gas clouds or between a dispersed gas cloud and a star.

The GFT beam will be very narrow. In another paper that I wrote: "A Model of a Gravitational Flux Tube between Two Stars", viXra: 2108.0141 shows that the GFT beam is very parallel, that is, very narrow. In that paper, the view is from Quantum Loop Gravity theory and spin networks.

Discussion on how the GFT structure will affect stellar rotation curves and differential rotations of stars in spiral galaxies?



Astronomers' estimate of the shape of our Milky Way galaxy Ref. 6

Messier 1010 Pinwheel Galaxy Ref.7

Looking at rotation curves of our Milky Way galaxy and at actual astronomical pictures of spiral galaxies, one can see that these galaxies are not tightly wound, usually one to two windings. Why are spiral galaxies not more tightly wound?

Differential rotations of stars in spiral galaxies have been suppressed by the newly proposed structure between stars due to gravitational flux tubes. The whole galaxy tends to rotate together as a unit. This does not hold for outlying dispersed gas clouds. This gravitational structure tends to increase stellar velocities farther from the galactic center, but is opposed by the inertia of the outlying stars. This structure is not strong enough to totally prevent differential rotations. It has been estimated that the Milky Way galaxy has rotated about 50 to 60 times. Our Sun has orbited the galactic center 20 times. Without the galactic gravitational structure due to gravitational flux tubes, the spiral would be as tightly wound as a spring in a mechanical clock. This can be considered as observational evidence

that a galaxial gravitational structure has existed. It is also confirmed by pictures of other spiral galaxies.

References:

Ref. 1 Milgrom, M. (1983). “A modification of the Newtonian dynamics as a possible alternative to the hidden mass hypothesis”. Astrophysical Journal. **270**:365-370

Ref. 2 Wikipedia: is the source of most information about the Milky Way galaxy, our Sun, stars around the Sun, gravitational theories, and most physical constants used in this paper.

Ref. 3 Scarpa, R., European Southern Observatory, Chile. “Modified Newtonian Dynamics, an Introductory Review”.

Ref. 4 Tolman, R., Ehrenfest, P., Podolski, B. (1931). “On the Gravitational Field Produced by Light”. Physical Review Journal Archive, **37,** 602**.**

Ref. 5 Deur, A., University of Virginia, Charlottesville, VA “Effect of gravitational field self-interaction on large structure formation”. Elsevier physics letters B

Ref. 6 NASA. Generated picture of Milky Way Galaxy; http://photojournal.jpl.nasa.gov.jpeg/PIA19341.jpg

Ref. 7 ESA/Hubble, CC BY 40. https://commons.wikipedia