

Entangled Duality

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Abstract

Relativity and entanglement are very different phenomenon in spite of occupying the same galaxy. We find that galactic rotation curves are an excellent measure of the validity of assumptions made about the apparent velocity of interaction of entanglement variables. There is, of course, no motion at all, but it is convenient describe it as such for computational purposes. For instance, we find that an assumption of a non-local instantaneous kernel gives superb alignment with observed galactic rotation curves. The work below records the excellent results between observation and theory for a number of rotation curves. Note that particle speeds still follow relativistic constraints.

Keywords: Entanglement, Relativity, Duality, Galaxy rotation curve, Dark matter.

Introduction

This paper introduces the idea of a separation of relativistic effects and entanglement effects in a galaxy. It's not just convenience. If you treat the two phenomena separately, you get real results. Each phenomenon operates in its own domain. It is also not a question of nomenclature nor is it just semantics. It distinguishes between an ontological and an epistemological layer of reality.

Each of the separate domains is necessary for a complete description of the physics. It clarifies what is non-locality; it separates causation from correlation and attempts to reconcile quantum theory with relativity. Entanglement exists in a non-local domain. Relativity has dynamics.

How is this different from standard relativity? The difference occurs because we are not referring to particle speeds. We compute rotation curves, and the alignment, perhaps surprisingly, is excellent.

Galaxies are easily delineated into relativistic, R, or entangled, E, domains which are distinguished by their maximum apparent interaction speeds, which are: c in R and a non-local instantaneous kernel in E. This is not a signal velocity nor is it superluminal. It does not carry information and it preserves Lorentz causality. The E domain does not have forces. However, force *can* arise as emergent from the domain.

The interaction velocity in E is not a particle velocity and is not superluminal. We calculate galactic rotation curves using the postulate that interactions proceed at infinite speed, when of course, they don't proceed with any speed at all, but this is a useful fiction.

We compare those calculations with observation. The resulting disparities between observed curves and the theoretically generated ones are remarkably small for undistorted galaxies, with ratios in the range of 2-4. Distorted galaxies have greater disparities, in the range of 45-110.

Definitions of the R and E Domains

We shall assume that there is a duality of interactions in a galaxy [1, 2]. We identify R matter to follow Einstein relativity. For example, no relativistic interaction can occur at speeds greater than c . The great majority of work done in galactic astrophysics follows Einstein's relativistic laws and operates in domain R. We could term typical galactic matter as relativistic matter since it is so closely and broadly correlated with relativity and defines a relativistic domain.

The other kind of galactic matter, which doesn't obey the rules of relativity R, we will identify as entanglement matter E [3]. While the two share a galaxy, they don't share much else.

Entanglement matter E operates in its own domain distinct from relativity. If you speed up E matter, its mass will not increase. In reality, you cannot speed it up. It will be moving at its limit speed and will remain going that fast. One important quality about E matter is that it has no speed at all in the E domain. There is no spacetime. The E domain is non-local, instantaneous, and does not have forces. Forces can arrive as emergent quantities from the E domain from patterns of entanglement. Interactions occur with no time delay at all. There is no position or trajectory. If all this sounds wild and strange, it is.

E is a space of source constraints. An easy way to visualize E is as a group of springs. They work just fine in their own domain. The interesting thing about E is that the typical qualities of space can emerge from E. The duality of paths for interactions is integral to the nature of the universe, but that does not happen in E. There are no paths, but the space that emerges from E can have paths. Another variable is dark matter which is very useful for galactic behavior description.

Calculation of Galactic Rotation Curves

We are proposing that the universe will choose one of two different pathways to interact, either R relativity or E entanglement, depending on the physical situation. The apparent infinite interaction speed in E does not imply the usual relativistic effects. This interaction speed is not a breakdown, but a boundary principle. Particle motion in this scenario never occurs at such speeds. Interactions can do so in this formulation, but not particle motion.

For instance, if everything is moving at the same speed, there is no lag. If there is no spacetime in E, how could there be a lag? We get a single global entity. That is one enormous advantage of the postulate. It gives astonishingly precise alignment with observations of galactic rotation curves. The table below shows the results when observed data [5] are compared with computational results [6].

1. TABLE OF DISPARITY RESULTS FOR VARIOUS GALAXY TYPES

Galaxy	Distortion Type	Disparity
NGC 3198	None	2
M 33	None	3
NGC 2403	None	2
NGC 5055	None	3
NGC 6946	None	4
M 82	Starburst	60
NGC 2443	Warped spiral	60
NGC 3014	Irregular	55
NGC 1614	Major remanent	70
ARP 148	Collisional ring	80
Antennae	Tidal tails	110
NGC 2903	None	4
NGC 3621	None	2
NGC 1097	Barred spiral	45
NGC 1313	Irregular	50
NGC 2146	Starburst	65
NGC 3256	Merger remanent	75
NGC 4654	Tidal	70

I choose to report the galactic result as disparities because the results are almost pictorial and are easiest to digest. As the table illustrates, the low disparities, 2-4, work beautifully in alignment with the observational rotation curves. The model works because the E domain is a non-local instantaneous constraint which modifies the effective gravitational potential. The higher disparities come from galaxies that are themselves inherently distorted [7].

Why does our rotation curve model give such good results? Because it is non-local by construction. Instantaneous global coupling gives the correct effective potential. In effect, we are going from a differential equation to an integral equation.

Theories of Missing Gravity

Does the universe really select which path to take or is it like water running downhill, where the water takes the path that requires the least energy?

It sounds like the universe required more gravity to hold itself together. However, there wasn't enough mass in the stars and planets to supply the requisite amount of gravitational force. As a result, physicists conjured up the missing mass out of the pliant emptiness. Yes, they thought, the required mass is there but you just can't see it. We'll call it dark matter. They even invented particles to supply the missing mass, named Weakly Interacting Massive Particles (WIMPS). As it turns out, missing mass was not the problem at all with galactic rotation. It was missing force.

Thus, there has been a long and frustrating search for those huge but barely discernable WIMPY ghosts. None were ever found, but the search went on. It's still going on.

If you keep looking for something for 50 years, there is a good chance it doesn't exist. So why don't the galaxies disappear into the mists of infinite space? Perhaps because scientists have been searching for the wrong thing. The existence of a measurable rotation curve implies something happens between the two objects even if no signal or force is transmitted. No force or signal is transmitted, but something measurable happens at the target. We might have to take refuge in the word probability.

Questions About Dark Matter and WIMPs

Does the model of separate E and R domains explain the many anomalies in galaxies? No. Then what good is it? The answer is that it elevates the role of entanglement. It shows that spacetime could emerge from entanglement, not the other way around. It suggests that entanglement could be more fundamental and important than spacetime.

We must also deal with dark matter that nature apparently has thrown into the pot. It serves a multiplicity of roles. In the beginning of their quest, scientists invented a type of dark matter – WIMPS, massive particles that supplied enough gravity to hold a galaxy together. Scientists spent 50 years in a fruitless search for this matter, but to no avail. In all these years, other ideas came to the fore such as emergent gravity which didn't need a massive object to create it. Except for WIMPs, dark matter still appears to be the best explanation.

We will now formulize the idea that the foundation of the universe has two domains, separate and distinct. The relativistic domain uses general relativity R to express itself. It has been enormously successful. The entanglement domain, E, has received less exposure. It could be considered a quantum informational field that is effective in curvature. It mimics dark matter without particles, but it actually appears to be more fundamental than spacetime.

What have we surmised? The universe has two pathways to achieve its goal of possible minimal expenditure of energy or possible maximal beauty or maybe something else. We need Einstein's relativity for a rational universe, but we also need entanglement. The new entanglement ideas do not diminish or extinguish relativity – they augment it.

Explanations for Missing Gravitational Force

Into this mix let us propose some core axioms. Spacetime is emergent. The Quantum Informational Field (QIF) is apparently a legitimate scientific tool which gives its stamp of approval to the entanglement domain in the same way that general relativity vouches for the relativistic domain. The QIF reports the effects and curvatures which mimic dark matter without particle sources.

The universe expands, but it isn't necessarily visible particles with massive gravitational force that keeps the universe stable. In other words, we don't necessarily need dark matter all the time, but presently it certainly is the chief culprit.

The infinite speed fiction of entanglement gives superbly precise galactic rotation curves with a remarkably small disparity between observation and experiment. But the reason that the rotation curves must interact at all is so there is no lag. Everything is instantaneous, and there is no place for any hesitations.

The initial postulate is that entanglement interactions take care of the rotation curves. So our repugnance for WIMPs reveals itself because there can be no lag in the quantum description of motion. Everything is immediate. It is difficult to discern what else would give the correct answers. Voila, it all hangs together!

Do galaxies move coherently? Yes, they do because the gravitational response at any point depends on the entire mass distribution simultaneously. Distant galaxies show large-scale correlated polarizations revealing large quantum coherence.

The Bullet Cluster

Now let us consider one of the great galactic anomalies, the Bullet Cluster. The R domain matter obeys relativity and E matter obeys entanglement. The E domain is not a field and is responsible for cohesion and gravitational scaffolding. What causes light to bend in the Bullet Cluster [8]?

The Bullet system is complicated by the gas moving in one direction and the matter moving in another direction. Galaxies in clusters exhibit phase alignment, not gravity alignment. Galaxies move as coherent objects.

Consider entanglement density across galaxies, clusters, and cosmology. Galaxy rotation curves predict declining velocities at large radii. Baryons by themselves predict declining velocities at large radii. Velocity curves flatten during observed galaxy rotations without postulating exotic particles. Gas is collisional and lags behind in mergers.

Galaxies are collision-less and move ahead. Entanglement tracks galaxies, not gas, so lensing peaks align with galaxies and are offset from X ray gas, matching Bullet Cluster behavior [9].

Cosmology and Cosmic Microwave Background (CMB) treat entanglement as pressure-less dust in Friedmann equations. It deepens gravitational wells, sets correct acoustic peak values in the CMB, and boosts growth. No exotic dark matter is needed. Entanglement acts as a collision-less, pressure-less-stress energy component that scales with baryons at galaxy scale. It localizes galaxies in clusters. It is quite simple: one rule, three scales, one effect.

Other Applications

Can our duality model of E and R domains help anywhere else? Yes, lensing gives a picture of the curvature of space. If that curvature is produced by E and R duality, we surprisingly have the variables we can use to investigate curvature. I'm not going to do it here, but the pathway is obvious. Is E responsible for coherence and scattering? Yes on the first, no on the second.

We argue that entanglement structure (E) and relativistic geometric structure (R) possess independent ontological status and should not be identified with one another, even in emergent-spacetime frameworks. While contemporary approaches — such as ER=EPR, holographic duality, and tensor-network reconstructions — tend to conflate entanglement with geometry, I propose that E and R are distinct but interacting layers of physical description. Entanglement defines a correlation topology in Hilbert space, whereas relativity defines a causal-metric structure in spacetime. Curvature arises not from either layer alone but from the compatibility conditions imposed when E and R are jointly realized.

One can develop a model illustrating how curvature emerges from mismatches between entanglement-defined adjacency and relativity-defined causal distance. This two-layer ontology avoids conceptual circularity in emergent-gravity programs, clarifies the role of duality constraints, and provides a new interpretational framework for gravitational phenomena such as lensing. The separation of E and R offers a more flexible foundation for quantum gravity, one in which geometry is neither fundamental nor reducible to entanglement, but instead arises from their structured interaction. The separation of E and R is crucial in this. Geometry comes from the structured interaction of E and R. E and R have different ontological requirements and should not be mixed as similar even in emergent spacetime.

Typical approaches conflate entanglement with geometry. In this approach E and R are distinct although they interact. Entanglement is the correlation topology in Hilbert space while relativity is the causal metric structure in spacetime. Curvature emerges from mismatches between entanglement adjacency and relativity defined causal distance. The two-layer ontology is irreplaceable in emergent gravity definitions. It clarifies the role of duality constraints and identifies a different view of gravitational lensing. We reiterate that E and R are

independent. Curvature is an interaction effect. Curvature is a mismatch between E distance and R distance. Lensing is the optical result of E and R compatibility. In the E and R dual-layer framework, E is correlation topology and R is causal metric structure. Black holes are regions of maximal divergence structure.

What is new in all this? E and R are separate and distinct, although they may come from the same galaxy. They do not conflate. Separating E and R clarifies spacetime and gives a new way of interpreting curvature. We get two layers of E and R. Curvature is a mismatch between E distance and R distance.

Conclusion

The premise in this paper is that relativity and entanglement are so different that they should be treated as separate entities. They each have their own specialized domains in which they operate.

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