

Entangled Duality

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Abstract

Relativity and entanglement can coexist in the same galaxy. A galaxy has two domains: Relativity R and Entanglement E. They are distinguished by their interaction speeds, which are the speed of light c in R, and infinity in E. Postulates are that R has distance motion time, while E has non-local interactions. We calculate galactic rotation curves in the E domain using the postulate that interactions proceed at infinite speed. We compare those calculations with observation. The resulting disparities 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. The rotation curves yield excellent alignment with observation.

About the R and E Domains

There is a duality of interactions in a galaxy, which we label R and E [1, 2]. Spacetime lives in R. R has geometry which follows Einstein relativity. R is a manifold whose coordinates map to a subset of R. R is subject to Lorentz invariance. The majority of work in geometry is stress energy divergence done in domain R. Call it relativistic matter.

There is another type of matter which we will identify as entanglement matter E [3]. While the two share a galaxy, they don't share much else. If you speed up E matter, its mass will not increase. It will move at its limit speed, which is infinity, and will keep going that fast. E matter has one velocity [4] and no delay.

The R domain is characterized by spacetime, geometry, stress energy divergence, and forces. R remains locally causal even when E is the cause and effect. E shows up in R only as stress-energy fields and their divergences which define local forces. There is no superluminal signaling in R. Instantaneous curvature changes are globally constrained not locally. Instantaneous effects are confined to E because E has no spacetime and no geometry. R is causal because it does have spacetime and geometry. E is a space of source constraints. An easy way to visualize E is as a web of springs between objects. They work just fine in their own domain.

The duality of paths for interactions in such situations is integral to the nature of the universe [5]. E is a coherent non-local regime. It generates an effective potential which produces a force. The effect adjusts instantaneously across the entire domain. E contributes a stress energy component that couples to Einstein's equation like a pressure-less, non-radiative field. By separating R and E into distinct domains we reconcile instantaneous correlation with relativistic causality. E is a non-local field moving at infinite speed responsible for coherence and

gravitational scaffolding. Curvature cannot propagate instantaneously, but the change in curvature can.

Once again, E has structure. R has dynamics. E is relational, informational, and entanglement-based. E provides correlation rules, and is non geometric. R converts rules into fields and forces. E is a coherent regime whose non locality maps into the R local curvature, which probably produces gravitational effects.

Characteristics of the R and E domains and facets of the E domain are further explored in the Appendix.

Calculation of Galactic Rotation Curves

We are proposing that the universe can choose one of two different pathways to interact, either R relativity or E entanglement, depending on the physical situation. Infinite velocity in this situation does not imply the usual relativistic effects. Infinite velocity is not a breakdown, but a boundary principle.

For instance, if everything is moving at the same speed, in this case infinity, there is no lag. . That is one enormous advantage of the infinite speed postulate. It gives astonishingly precise alignment with observations of galactic rotation curves. The table below shows the results.

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

As the table illustrates, the low disparities, 2-4, work beautifully in alignment with rotation curves. The higher disparities come from galaxies that are themselves somehow distorted [6].

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? That is a principle of minimal energy. It sounds like the universe required more gravity to hold itself together and there wasn't enough mass in the stars and planets to supply the requisite amount of gravitational force.

If there wasn't enough visible mass to do the job, 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. Very poetic. They even invented particles to supply the missing mass: Weakly Interacting Massive Particles, named WIMPS. As it turns out, missing mass was not the problem at all with galactic rotation. It was missing force.

There are now other candidates to supply missing gravity. How about quantum theory and emergent gravity? Thus, there began a long and frustrating search for those huge but barely discernable WIMPy ghosts, but none were ever found. But the search went on and it's still going on.

The easiest way out is to assume the ghosts don't exist. If you can't find them, the answer is simple, they do not exist! So why don't the galaxies disappear into the mists of infinite space? Because you are searching for the wrong thing. Gravitational force is there, but it's not coming from those enormous heavy, quietly whispering particles. It's coming from the depths of quantum theory. So, in the second part of this paper we look at a galaxy without dark matter.

The Nature of Force

A few words about force. Suppose you are sitting in E and push a book across a table. It's not so simple. If E has no geometry, where did the table come from? A push or pull is called a fundamental force. Emergent forces are not fundamental forces. They may act like one, and they could even be a push or pull, but if they arrive from quantum theory, they are not fundamental. They are emergent.

There is no inherent force in E, only constraints. E has structure, R has dynamics. E provides the correlation rules. R converts those rules into fields and forces. A fundamental force is when you push a book along a table. The force is in R. E is the universe's logic. Logic does not push or pull. It is not a force. E does not create fundamental forces. When R emerges from E this correlation will manifest as force. How? Forces in R are real but not fundamental because their origin lies in a correlation in E. You cannot tell the where a push or pull in E came from. The origin of the force is masked. Quantum mechanics does not leave an imprint. A shorthand

way of looking at it is that E is foundational and R is emergent. Forces in R are real but not fundamental. Foundational is not necessarily fundamental. Yet in all of this, E is the driver of what is happening.

Questions About Dark Matter and WIMPS

Without dark matter the galaxies should not hold together, but they do. There should not be a cosmic web, but there is. Are there too few galaxies and clusters, no, there are plenty. There should be faster expansion, but expansion is just fine. Stars should flee galaxies, but they don't. Gravitational lensing should not occur, but it does. The cosmic microwave band should disappear, but it's still with us. Dear reader, you might have guessed what is happening. Could it be that there another source of gravity in addition to planets and stars?

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, that supplied enough gravity to hold a galaxy together but that nobody could find, and that some people believe still exists. This was matter that was conjectured to exist, but does it? Scientists realized the universe required more gravity to hold it together. They spent 50 years in a fruitless search for this matter, but to no avail because it was not matter. It was force, gravitational force.

Now presuming something existed, which for 50 years scientists looked for but never could find, the search was an exercise in futility. In all these years, other ideas came to the fore such as emergent gravity which didn't need a massive object to create it. There are still situations where dark matter appears to be the best explanation, such as lensing. Why are the galaxies holding together as they do? Why is there the cosmic web? Why are there so many galaxies? Why isn't there a faster expansion? Why are there so many clusters and how to explain galactic stability?

However, if there were no dark matter how would you explain galaxies holding together, or the existence of the cosmic web, or why there are so many galaxies, and why there isn't faster expansion, and why there are so many clusters, and why there is lensing, and why there is a cosmic microwave band? The answer is below.

A Brief Review

We will now revisit the idea that the foundation of the universe has two domains. The relativistic domain uses general relativity R to express itself. It has been enormously successful. The entanglement domain, E, has received less exposure. What holds galaxies together? Perhaps a quantum informational field that is effective in curvature that mimics dark matter without particles.

As a review, R is a structured object in spacetime with fields, metrics, and local dynamics. E is a space of sources and constraints. It is not geometric. E has no spacetime geometry, no metric, no light cones, no stress energy. R has geometry, spacetime, energy, divergence forces. The source of emergent force in the universe is in E. The force itself is in R, an effective potential or divergence of stress energy. Force is in R. Entanglement is in E. The Hamiltonian depends on entanglement configuration and updates with infinite speed and entangles instantaneously with energy in R and force in R.

The upshot of all this is that the universe has two interacting domains. There is a relativity domain, R, with Lorentz invariance, and an entanglement domain, E, with instantaneous correlation. E contributes a stress-energy component that couples to Einstein's equation like a pressure-less non-radiative fluid. This produces flat rotation curves without halos, explains lensing in cluster collisions by tracking bound galaxy potential, and maintains deep gravitational wells during recombination preserving CMB peak ratios. By separating R and E into distinct domains we reconcile instantaneous correlation with relativistic causality.

Connectivity is alluring but I am not going there. The universe acts like a quantum entangled fluid. In this rendition, the universe behaves like quantum connectivity, and mass is not the origin of gravity.

Entanglement interactions are instantaneous. No need for dark matter. Galactic motion is synchronized, space time is emergent, gravity is perhaps a macroscopic illusion. The universe is a quantum entangled fluid. Galaxies are not isolated masses but nodes in a vast non-local network whose dynamics follow phase relationships and coherence gradients.

Observational tests could include: massless lensing, coherence mapping, and phase drift in galactic clusters. Perhaps phase drift in galactic clusters is the new connectivity reality principle.

Core axioms are the following. Spacetime is emergent. Gravity comes from quantum coherence, not dark matter. Galaxies move as coherent entities. There is massless lensing. Galaxies in clusters exhibit phase alignment not gravity alignment. Distant galaxies show correlated polarizations.

Does nature seek minimum energy expenditure interactions? If not, what? Perhaps there is something else that the universe seeks to minimize or maximize.

What could that be? Look at the sky on a starlit night. What is the first thing that comes to mind? Beauty. Perhaps that's a maximal principle. Perhaps the universe seeks to increase its beauty. And it's not just physical beauty. The work necessary to put the universe together is an act of great beauty.

What of entanglement? It conflicts with relativity, mostly with the allowed possible velocities of interaction. But infinite speed of entanglement does give the correct galactic rotation curves.

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. Entanglement is primary. Gravity originated in quantum coherence. 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. Entanglement in the universe's energy/density is what behaves like matter.

The universe expands, but it isn't particles with massive gravitational force that keeps the universe stable. It is quantum mechanics that creates the gravity which holds the universe together. It is gravity from someplace other than particles. In other words, we don't necessarily need dark matter all the time, but it certainly appears useful. However, there is quantum mechanics which is responsible for gravitational force. And it is a quantum-derived force which moves at infinite speed because if it didn't, things would lag behind reality and would be noticed.

Entanglement is primary. Spacetime is emergent. It is not fundamental. Gravity came from quantum coherence. It is called emergent gravity and it is astonishing that gravity can arise from quantum theory. Galaxies move as coherent entities. Distant galaxies show large-scale correlated polarizations revealing large quantum coherence.

The infinite speed entanglement postulate gives the superbly precise galactic rotation curves with the remarkably small disparity between observation and experiment. But the reason that the rotation curves must be moving at infinite speed is so there is no lag. Everything is instantaneous, and if everything is moving at infinite speed there is no place for any hesitations.

The initial postulate that entanglement interactions occur at infinite speed means that entanglement interactions take place at infinite speed, and that takes care of rotation curves. So, our repugnance for WIMPs reveals itself because there can be no lag in the quantum

description of motion. No other galactic velocity gives the correct answer for instantaneous galactic motion. Voila, it all hangs together!

The Bullet Cluster

Now let us consider one of the great galactic anomalies, the Bullet Cluster. Light bends in the Bullet Cluster and it appears to come from mass, and we have just argued that dark matter may not exist. The R domain matter obeys relativity and E matter obeys entanglement. E is non local that moves at infinite speed and is responsible for cohesion and gravitational scaffolding. What causes light to bend in the Bullet Cluster [7]?

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. Clusters (Bullet Cluster) 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 [8].

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.

Conclusion

The premise in this paper is that relativity and entanglement are so different that they cannot be treated in a universal way. They each have their own domains in which they operate. It is remarkable that they can both inhabit the same galaxy.

Appendix

Characteristics of the R and E Domains

E behaves like a global constraint. All degrees of freedom in R have corresponding source variables in E. E enforces consistency conditions across the entire universe at once. R is the emergent geometric projection of those global constraints.

E is not a field or a wave function. It is a timeless algebraic space of constraints. E updates instantaneously so every mass in the universe contributes to the constraint structure of every other mass. That implies inertia is global. Local dynamics depend on total mass distribution. Rotation curves will flatten without dark matter.

In R, this results in a relativistic force law. Although they are very different, E and R can communicate requiring no time which implies non-local causation without paradox. E can coordinate entangled states. E can enforce global conservation. E can cause “spooky” correlations in R. Are you listening Albert?

However, E is outside spacetime, so no paradox. This results in quantum entanglement, Bell correlations, instantaneous collapse, and global conservation constraints. Since E is the domain of sources, R’s forces are emergent projections. Curvature in R is the geometric expression of E. Gauge fields in R could be bookkeeping for E constraints. This therefore unifies geometry (gravity), gauge symmetry (electromagnetism), and quantum entanglement (non-local constraint). The E domain is paramount.

Now the wild ride. E implies R is an emergent simulation layer. R is the world. E is the engine. R has locality and geometry. E has none of this, but determines everything. E is the real ontology. R is emergent.

Facets of the E Domain

In E, everything is adjacent to everything else. No distance, no metric, no locality. All degrees of freedom are accessible. Constraints can be solved globally rather than locally. There is no lag between any two points.

How can there be infinite speed interaction? It’s a constraint structure instead of dynamics. E does not evolve in time. It resolves like a timeless algebraic space of consistency conditions. It enforces global coherence across R. It is a domain where laws are relations, not differential equations.

Every physical quantity in R has a source variable in E. Mass in R is an inertia source in E. Charge in R is a gauge source in E. Spin is a symmetry source in E.

For any change in R, E updates the entire constraint network. Entanglement correlations are without signals, non-local global conservation laws, gravity emerging from universal coupling.

E has no metric but it does have structure. R is a projection of E; therefore, spacetime emerges from constraints, and forces emerge from E coupling, R is visible; E is the engine. E has no time. The arrow of time exists only in E. Local acceleration depends on entire mass, galactic rotation curves flatten naturally, Mach's principle becomes literal.

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