Gravity is Light

A New Picture of the Universe

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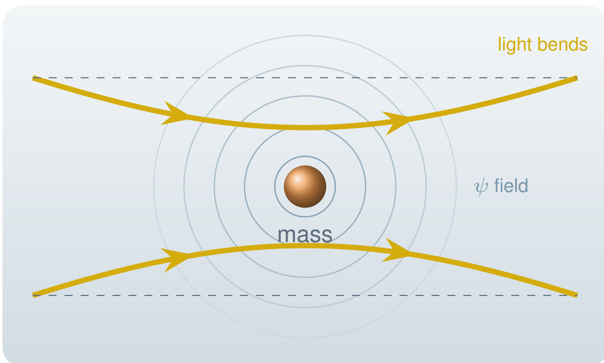
A Complete Layperson's Guide to
Density Field Dynamics



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Core promise to the reader:

"We are going to show you a completely different picture of gravity —
one where space doesn't curve, but light slows down.
We'll show you how that single idea resolves five of the biggest mysteries in physics.
And we'll tell you exactly how you could prove us wrong."

Contents

Preface: A Note on Honesty

> "The first principle is that you must not fool yourself — and you are the easiest person to fool."
>
> — Richard P. Feynman

I am not a professor. I do not have a PhD in physics. I work in finance during the day, and I work on physics in every other hour I can find. I tell you this upfront because honesty is the only currency that matters in science.

The theory in this book — Density Field Dynamics — began with a simple question: *what if gravity isn't curved spacetime, but a refractive medium?* What if light doesn't bend near the Sun because space is warped, but because light *slows down* in the region near a mass, exactly the way it slows down in glass or water?

That question led, over years of work, to a complete mathematical framework. One that reproduces every test of Einstein's General Relativity. One that explains why galaxies spin flat without invoking invisible matter. One that derives the fine structure constant — the most mysterious number in physics — from pure geometry. One that makes specific, quantitative predictions that can be tested with instruments that already exist.

I want to be clear about what this book is and isn't.

What it is: An honest guide to a new theory. Every claim is backed by a specific equation, a specific dataset, or a specific experimental prediction. When something is derived, I'll say "derived." When something is assumed, I'll say "assumed." When something is incomplete or uncertain, I'll say that too.

What it isn't: An appeal to authority. I have none. What I have instead is a theory that makes falsifiable predictions — predictions that can be tested and that would kill the theory if they come out wrong.

That's the deal I'm making with you. I've told you exactly how to break this theory. Now I invite you to try.

> *The reader's compact: I'll be honest about what's proven, what's derived, and what's still a guess. In return, I ask only that you follow the logic.*

— Gary Alcock, February 2026

Part I

The Problem

Why physics needed a new idea

Chapter 1

Einstein Was Right — And That's the Problem

> "The most incomprehensible thing about the universe is that it is comprehensible."
>
> — Albert Einstein

1.1 A Century of Being Right

In 1915, Albert Einstein published a set of equations that redefined our understanding of gravity. His theory — General Relativity — said something astonishing: massive objects don't pull on each other through empty space. Instead, they *warp the fabric of spacetime itself*. Everything — planets, light, even time — follows the contours of that warping.

It was a bold claim, and nature confirmed it. In 1919, Arthur Eddington measured starlight bending around the Sun during a solar eclipse, exactly as Einstein predicted. Mercury's orbit, which had stubbornly refused to match Newton's equations for decades, finally agreed with the new theory to exquisite precision: 42.98 arcseconds of precession per century. Radio signals passing near the Sun slow down by exactly the predicted amount — the Shapiro delay. And in 2015, a century after Einstein published his equations, the LIGO detectors heard the spacetime vibrations from two colliding black holes — gravitational waves, ringing at precisely the frequency General Relativity predicted.

> *General Relativity has never once been wrong in any experiment we've done in the solar system.*

So why propose something different? Because Einstein's triumph comes at a breathtaking price.

1.2 The Dark Sector Problem

In 1933, the Swiss astronomer Fritz Zwicky was studying the Coma galaxy cluster — a swarm of over a thousand galaxies bound together by gravity. He measured how fast the individual galaxies were moving, and he calculated how much mass the cluster needed to hold itself together. The answer was alarming: the cluster needed roughly ten times more mass than its visible stars could provide. Zwicky called the missing ingredient *dunkle Materie* — dark matter.

For decades, his observation was treated as a curiosity. Then, in the 1970s, the astronomer Vera Rubin changed everything. Rubin and her colleague Kent Ford measured the rotation speeds of stars in spiral galaxies. According to Newton and Einstein, stars in the outer reaches of a galaxy should orbit slowly — just as Neptune orbits the Sun more slowly than Mercury. The gravitational pull of the visible matter should weaken with distance.

That's not what Rubin found. The outer stars were moving *just as fast* as the inner ones. The rotation curves were flat, not falling. Something invisible was holding the galaxies together.

The problem only deepened. In 1998, two teams of astronomers — led by Saul Perlmutter and Adam Riess — discovered that distant supernovae were fainter than expected. The universe wasn't just expanding; it was *accelerating*. Whatever was pushing it apart was dubbed "dark energy."

The cosmic accounting now looks like this: ordinary matter — the atoms that make up you, me, the Earth, every star in every galaxy — accounts for roughly 5% of the total energy content of the universe. Dark matter accounts for 27%. Dark energy accounts for 68%.

> *In any other field of science, if your model required 95% of its ingredients to be undetected, you'd suspect the model.*

1.3 The Acceleration Coincidence

There is a strange number hiding in the galaxy rotation data. Below a characteristic gravitational acceleration of about $a_0 \approx 1.2 \times 10^{-10}$ m/s^2, galaxies consistently depart from Newtonian predictions. Above that threshold, everything looks normal.

In 1983, the Israeli physicist Mordehai Milgrom noticed something remarkable. This number a_0 is eerily close to the product of the speed of light and the Hubble constant: $c \times H_0$. The scale at which individual galaxies go strange is connected to the scale of the *entire observable universe*.

The Acceleration Coincidence

Standard Cosmology (ΛCDM)	Density Field Dynamics
"It's a coincidence. Dark matter halos just happen to produce dynamics that mimic this threshold."	"It's a derivation. The crossover acceleration is $a_* = 2\sqrt{\alpha}\, c\, H_0$, derived from the topology of the microsector."

1.4 What a Better Theory Would Look Like

Before we build the alternative, let's agree on the standards it must meet. A viable replacement for standard gravity would need to:

1. **Reproduce every GR success** — Mercury's perihelion, light bending, Shapiro delay, gravitational waves — to the same precision.

2. **Explain galaxy dynamics** without invoking an invisible substance that has never been directly detected.

3. **Explain cosmic acceleration** without invoking an invisible energy that violates quantum mechanical expectations by 120 orders of magnitude.

4. **Make new, falsifiable predictions** — specific tests that could prove it wrong.

Such a theory exists. Let's build it.

Chapter Summary

The DFD one-liner: Einstein's gravity works perfectly — but it needs 95% of the universe to be invisible. DFD asks: what if the model, not the universe, needs fixing?

What would confirm this chapter's premise: Continued non-detection of dark matter particles. Growing tension in cosmological parameters. New anomalies at the a_0 threshold.

What would break it: Direct laboratory detection of a dark matter particle with properties consistent across multiple experiments. Resolution of all galactic anomalies within ΛCDM without fine-tuning.

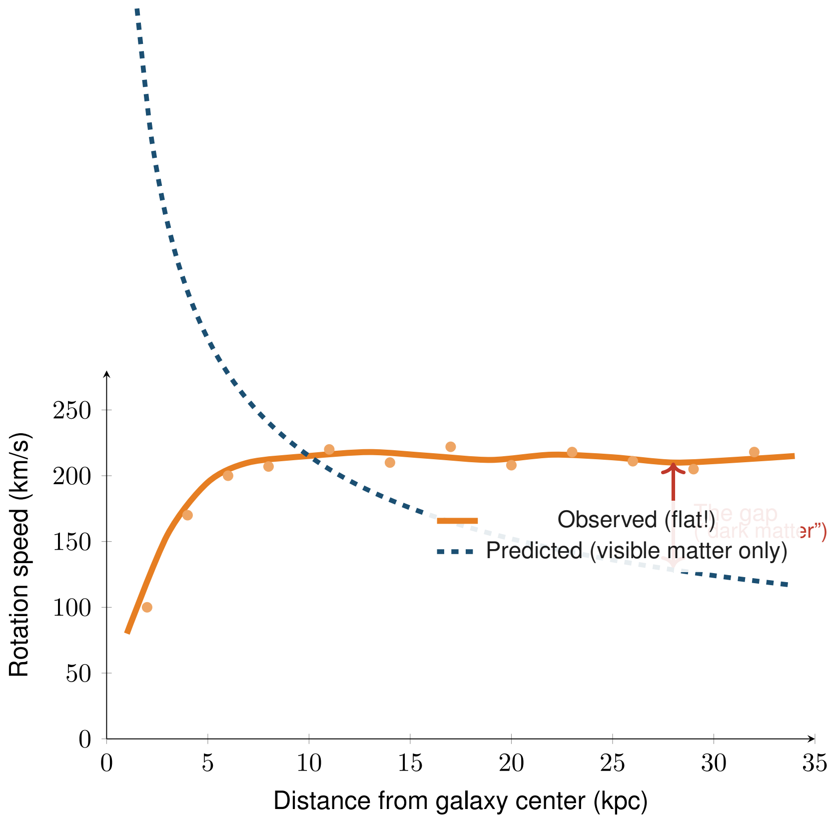


Figure 1.1: **The galaxy rotation curve puzzle.** Stars in the outskirts of galaxies orbit just as fast as stars near the center. The blue dashed line shows what visible matter alone predicts. The orange line is what we actually observe. The gap between them is what physics calls “dark matter.” *Or is it?*

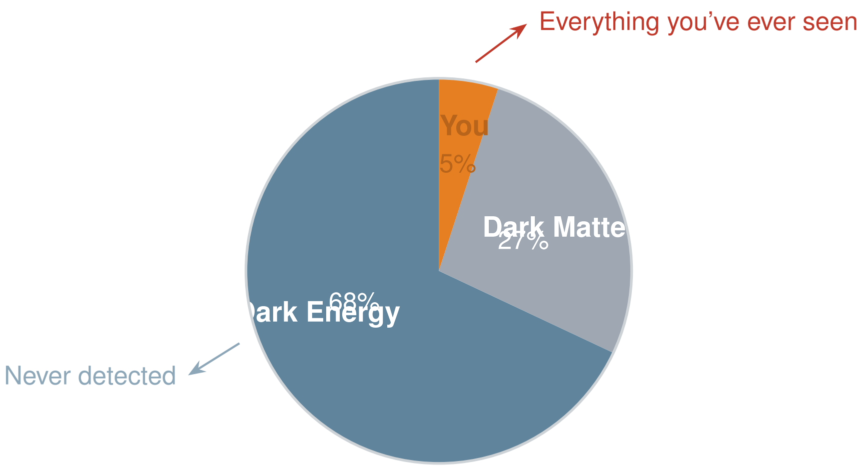


Figure 1.2: **The cosmic budget.** We've detected 5%. The other 95% is a placeholder for our ignorance.

Chapter 2

The Road Not Taken — Gravity as Optics

> "Nature uses only the longest threads to weave her patterns, so each small piece of her fabric reveals the organization of the entire tapestry."
>
> — Richard P. Feynman

2.1 Light Doesn't Always Travel in Straight Lines

Put a straw in a glass of water. It appears to bend at the surface. Drive down a highway on a hot day. You see shimmering pools of "water" on the road that vanish as you approach — a mirage. Watch a sunset. The Sun appears above the horizon for several minutes after it has geometrically dropped below it.

These are all the same phenomenon: light bending when it moves through a medium where its speed changes. The rule governing this bending was discovered by Willebrord Snell in 1621: light crossing a boundary between materials bends toward the material where it travels slower.

The key concept is the **refractive index**, denoted n. It tells you how much slower light travels in a medium compared to vacuum. In glass, $n \approx 1.5$, so light travels at about two-thirds its vacuum speed. In air, $n \approx 1.0003$ —

barely different from vacuum, but enough to produce mirages and lingering sunsets.

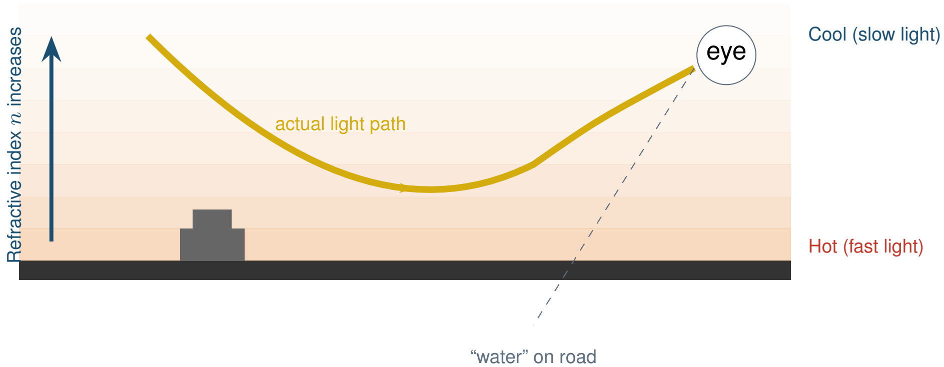


Figure 2.1: **The mirage effect.** Hot air near the road surface has a lower refractive index (light travels faster). Light from the sky curves upward, creating the illusion of water on the road. This is exactly the physics DFD uses for gravity — but with mass instead of heat creating the gradient.

The crucial insight: you don't need a sharp boundary. If the refractive index changes *gradually* across space, light traces smooth curves. No surfaces, no edges — just a continuous medium with varying properties.

2.2 Fermat's Principle: Light Takes the Fastest Route

There's a beautiful deep principle at work here. Light doesn't "know" about Snell's Law. It simply takes the path that minimizes travel time — Fermat's Principle, discovered in 1662.

Think of it this way: if you're a lifeguard who needs to reach a drowning swimmer, and you run faster on sand than you swim in water, you wouldn't run straight toward them. You'd angle your path — running farther along the beach and entering the water closer to the swimmer. The fastest path isn't the straightest one.

Light does the same thing. And if you fill *all of space* with a varying refractive index, light will trace curved paths through that space — even though the space itself is perfectly flat.

2.3 The Optical Gravity Idea

Here's a historical fact that most physics students are never taught. In 1911 — four years before completing General Relativity — Einstein himself calculated that light should bend near the Sun. He did this calculation using a *varying speed of light* near a massive body, treating gravity as a kind of optical effect. He got half the right answer. The other half, he later concluded, came from the curvature of space itself.

DFD asks a provocative question: *what if both halves are optical?*

What if there is no curved spacetime — only a scalar field ψ (pronounced "sigh") that permeates all of space and acts like a refractive index? Where ψ is stronger, light slows down, clocks run slower, and objects accelerate — exactly as they would in an optical medium.

> *DFD's founding idea: replace the curved fabric of spacetime with a refractive medium. Every prediction of General Relativity follows.*

2.4 Fermat Meets Newton

In an optical medium, objects moving slowly compared to light still feel the gradient of the refractive index. The acceleration of a massive body is:

$$\boxed{\mathbf{a} = \frac{c^2}{2}\nabla\psi} \tag{2.1}$$

In plain English: Things accelerate toward regions where ψ is larger — where light is slower. The factor $c^2/2$ sets the scale. This is Newton's gravity, rewritten as optics.

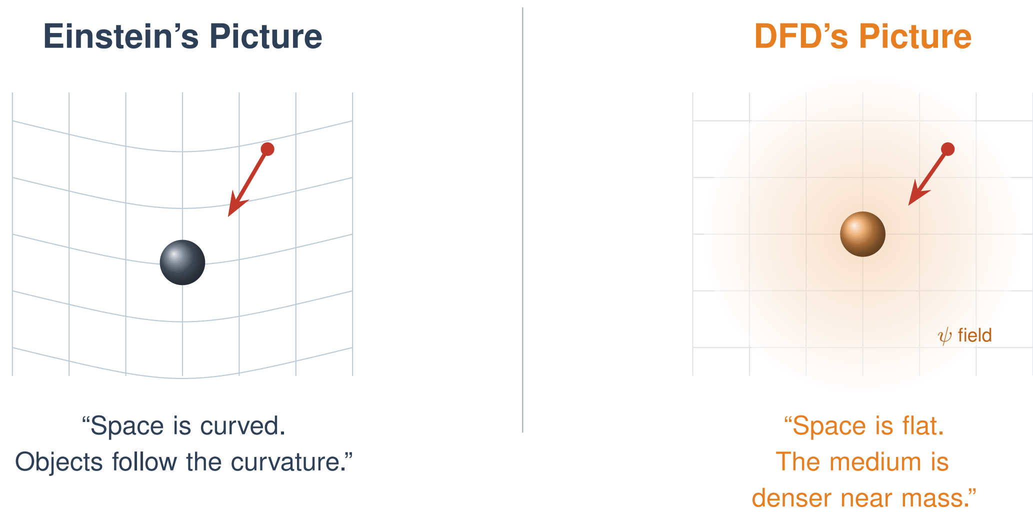


Figure 2.2: **Two pictures of gravity.** Left: Einstein's curved spacetime — a rubber sheet deformed by mass. Right: DFD's refractive medium — a flat space with a varying ψ field. Both predict the same observations in the solar system. They diverge in galaxies and cosmology.

The optical metric in DFD is simple and explicit:

$$d\tilde{s}^2 = -\frac{c^2\,dt^2}{n^2} + d\mathbf{x}^2 \tag{2.2}$$

In plain English: Space is flat ($d\mathrm{x}^2$ is just ordinary Euclidean distance). Time runs at a rate set by the refractive index $n = e^{\psi}$. Where ψ is large, n is large, and clocks tick slower. That's it.

Two Languages for Gravity

Einstein says:	DFD says:
"Space is curved." "Objects follow geodesics." "Time dilates because of curvature."	"The medium is denser." "Objects follow refractive gradients." "Time dilates because $n = e^{\psi}$."

How to tell them apart: Look at galaxies. Look at atomic clocks. Look at the cosmic microwave background.

Chapter Summary

The DFD one-liner: Gravity is not curved spacetime. It's light slowing down in a refractive medium — and everything else follows.
What would confirm: DFD-specific predictions (clock anomalies, galaxy dynamics without dark matter) matching observation.
What would break it: A genuine geometric effect of gravity that cannot be replicated optically — such as topology change in gravitational collapse that has measurable external consequences.

Part II

The Theory

What DFD actually says, piece by piece

Chapter 3

The Field — What ψ Is and Why It Works

3.1 The Refractive Index of Space

The ψ field is the simplest kind of physical field: a **scalar field**. At every point in space, ψ is just a single number — like temperature on a weather map, or altitude on a topographic map. There's no direction to it, no vector, no tensor. Just a number.

The refractive index of space is:

$$\boxed{n = e^{\psi}} \tag{3.1}$$

In plain English: e^{ψ} is the exponential of ψ. When $\psi = 0$ (far from any mass), $n = 1$ — vacuum. When ψ is positive (near a mass), $n > 1$ — light slows down, clocks run slower, objects accelerate inward. That's gravity.

Near a spherical mass M, the ψ field takes a simple form: $\psi \approx GM/(rc^2)$, where r is the distance from the center. The gradient points inward. Objects accelerate inward. That's gravity — rewritten as optics.

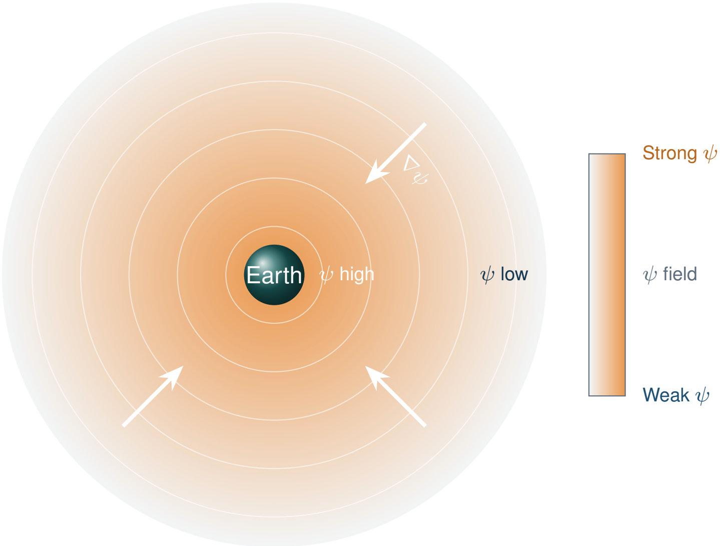


Figure 3.1: **The ψ field around Earth.** Near the surface, ψ is strongest — clocks run slowest, light bends most. Moving away, ψ weakens. The arrows show $\nabla\psi$, the gradient — the direction of gravitational acceleration.

3.2 The Field Equation

Every field theory needs an equation telling the field how to respond to matter. DFD's field equation is:

$$\boxed{\nabla \cdot \left[\mu\left(\frac{|\nabla\psi|}{a_*}\right)\nabla\psi\right] = -\frac{8\pi G}{c^2}\,\rho} \tag{3.2}$$

Piece by piece:

- $\nabla\psi$ — the slope of ψ, how fast it changes across space. This is what produces acceleration.
- $\mu(x)$ — a "throttle function." When gravity is strong, $\mu \approx 1$ (full strength). When gravity is very weak, $\mu \approx x$ (reduced throttle). This is where galaxies come from.
- ρ — the density of ordinary matter. Stars, gas, dust. The only source.
- G and c — Newton's gravitational constant and the speed of light.

The sentence version: Matter tells ψ how to arrange itself; ψ tells matter how to move.

This one equation, with no free parameters, governs gravity from the Solar System to the edge of the observable universe.

3.3 The Throttle Function — Where Galaxies Come From

The function $\mu(x)$ is the key to everything:

$$\boxed{\mu(x) = \frac{x}{1+x}} \tag{3.3}$$

When gravity is strong — in the solar system, near black holes, anywhere the acceleration exceeds a_* — the throttle is wide open: $\mu \approx 1$. The field equation reduces to exactly what GR predicts. Every solar system test passes

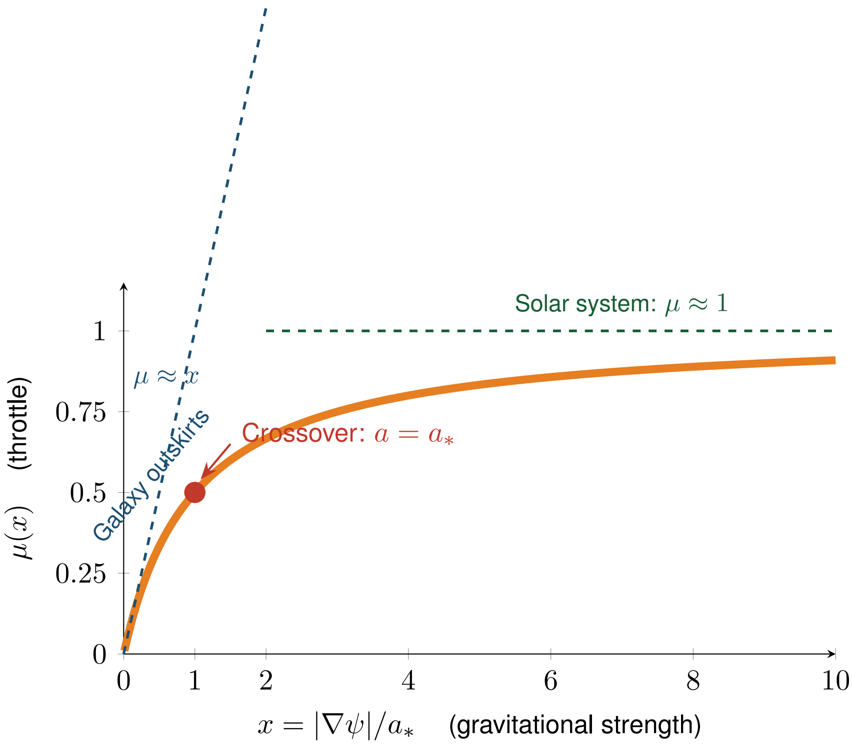


Figure 3.2: **The throttle function** $\mu(x) = x/(1 + x)$**.** When gravity is strong ($x \gg 1$), $\mu = 1$ and DFD is identical to GR. When gravity is weak ($x \ll 1$), $\mu = x$ and the field equation changes character — rotation curves flatten. The crossover happens at $a_* \approx 1.2 \times 10^{-10}$ m/s^2.

automatically.

When gravity is very weak — in the outskirts of galaxies, where the acceleration drops below a_* — the throttle closes: $\mu \approx x$. The equation changes character. The effective gravitational force strengthens relative to what Newton would predict. Rotation curves flatten. No dark matter required.

The critical insight: **this crossover function is not fitted to data.** It is derived from the geometry of a 7-dimensional mathematical space called

$\mathrm{CP}^2 \times S^3$. We'll meet this space in Chapter 6.

Where Does $\mu(x)$ Come From?

MOND (Milgrom, 1983)	DFD
Milgrom *chose* $\mu(x)$ to fit galaxy data. Multiple functional forms work. It's an empirical guess.	$\mu(x) = x/(1+x)$ is the *unique* output of a geometric theorem about the 3-sphere. It's derived, not chosen.

3.4 No Free Parameters

This claim sounds bold, and it is: DFD has **zero continuous adjustable parameters**.

The full ledger: two foundational postulates ($n = e^{\psi}$ and $\mathbf{a} = (c^2/2)\nabla\psi$), topological integers from the Standard Model structure, and one measured scale (the Hubble constant H_0, or equivalently Newton's constant G). Everything else — the fine structure constant, galaxy rotation curves, the crossover acceleration, fermion masses — is derived.

> *You measure one number. Everything else follows.*

Chapter Summary

The DFD one-liner: A single scalar field ψ, obeying one nonlinear equation with no free parameters, produces Newtonian gravity in strong fields and flat rotation curves in weak fields.
What would confirm: Rotation curve fits across hundreds of galaxies with zero adjustable parameters beyond known baryonic mass.
What would break it: A galaxy whose rotation curve systematically deviates from the DFD prediction by more than 3σ, with well-measured baryonic mass.

Chapter 4

Passing Einstein's Tests

4.1 The PPN Framework — How We Compare Gravity Theories

Physicists have a standardized language for comparing theories of gravity: the Parameterized Post-Newtonian (PPN) framework. It defines ten parameters — with names like γ, β, ξ, α_1 through α_3, and ζ_1 through ζ_4 — that characterize how any gravity theory behaves in the weak-field, slow-motion limit.

General Relativity's values: $\gamma = \beta = 1$, all others zero. These have been tested to extraordinary precision.

DFD's values: *identical*. $\gamma = \beta = 1$. All ten parameters match GR exactly.

> *DFD passes every PPN test by construction — not by luck.*

4.2 The Classic Tests

4.3 Gravitational Waves

On August 17, 2017, LIGO and Virgo detected gravitational waves from a binary neutron star merger — event GW170817. Crucially, a gamma-ray

Test	GR Predicts	DFD Predicts	Status
Mercury perihelion	$42.98''$/cy	$42.98''$/cy	✓
Light deflection	$1.75''$	$1.75''$	✓
Shapiro delay	Δt_{GR}	Δt_{GR}	✓
Gravitational red-shift	$\Delta f/f = g\,h/c^2$	$\Delta f/f = g\,h/c^2$	✓
GW speed (c_T)	c	c	✓
GW polarizations	2 tensor	2 tensor	✓
Frame-dragging	Ω_{GR}	Ω_{GR}	✓

Figure 4.1: **Every classical test of gravity: GR and DFD give identical predictions.** The green checkmarks mean the observation matches both theories to within experimental precision.

burst was detected 1.7 seconds later, after both signals had traveled 130 million light-years.

This single observation tells us that gravitational waves travel at the speed of light to better than one part in 10^{15}. This measurement killed dozens of competing gravity theories that predicted $c_T \neq c$.

DFD predicts $c_T = c$ exactly. Two tensor polarizations, exactly as GR predicts.

> *GW170817 killed dozens of competing theories. DFD survived.*

4.4 Black Holes and the Event Horizon Telescope

DFD predicts photon spheres — regions where light can orbit a compact object — at the same locations GR predicts. The shadows of M87* and Sgr A* observed by the Event Horizon Telescope are consistent with DFD.

The difference is interpretive: DFD calls them "optical horizons" rather than singularities in spacetime. What's different inside: DFD avoids the information paradox by having no fundamental singularity.

Chapter Summary

The DFD one-liner: DFD isn't fighting Einstein. It's reinterpreting him — and passes every test he passed.

What would confirm: New precision measurements continuing to match both GR and DFD.

What would break it: Detection of a gravitational effect that is genuinely geometric (not optical) — such as spacetime topology change with externally measurable consequences.

Chapter 5

Galaxies Without Dark Matter

> "The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them."
> — Sir William Bragg

5.1 Vera Rubin's Puzzle

In the 1970s, Vera Rubin and Kent Ford at the Carnegie Institution measured something that should have been routine: the rotation speeds of stars in spiral galaxies. Plot the orbital velocity against distance from the center. Textbook exercise.

Except the data refused to follow the textbook. Stars far from the galactic center orbited *just as fast* as stars near the center. The rotation curves were flat.

This has now been measured for thousands of galaxies. It's *always* flat.

5.2 Why Dark Matter Halos Are Uncomfortable

The standard explanation: an enormous halo of invisible matter surrounds every galaxy, providing extra gravitational pull that keeps the outer stars moving fast. This could be true. But notice what we're doing: for *every* galaxy, we infer a dark matter halo by working backward from what the rotation curve needs. We've been doing this for fifty years. We've never detected a dark matter particle directly.

Worse: the inferred halos have properties that seem to "know about" the visible matter in ways that dark matter shouldn't care about. The Radial Acceleration Relation (RAR) shows a tight, universal correlation between the observed gravitational acceleration and the acceleration predicted from baryonic matter alone. If dark matter is an independent, separately distributed component, *why does it always arrange itself to match the baryonic prediction so precisely?*

> *If dark matter is a separate substance, why does it always arrange itself in exactly the way ordinary matter demands?*

5.3 DFD's Answer: The Crossover

In DFD, there's no invisible matter. The ψ field itself behaves differently at low accelerations. When the gravitational acceleration falls below $a_* \approx 1.2 \times 10^{-10}$ m/s^2 — which happens in the outskirts of every galaxy — the throttle function $\mu(x)$ shifts regime. The effective force strengthens, not because of invisible matter, but because of how ψ responds to the baryonic source.

5.4 The Baryonic Tully-Fisher Relation

One of the tightest empirical laws in extragalactic astronomy:

$$V_{\text{flat}}^4 = G\, M_{\text{bar}}\, a_0 \tag{5.1}$$

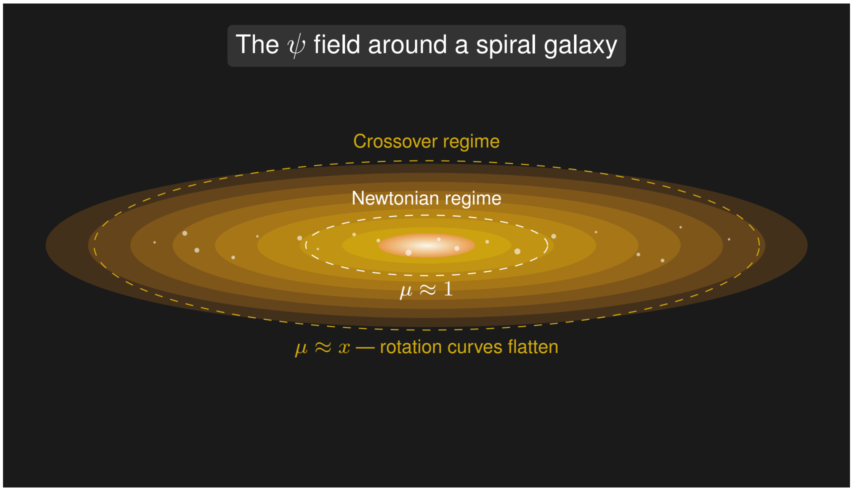


Figure 5.1: **Galaxy dynamics in DFD.** Near the center (white), the ψ field is in the Newtonian regime — everything matches Newton/GR. In the outskirts (gold), the field enters the crossover regime where $\mu \approx x$. Rotation curves flatten automatically. No dark matter halo required.

In plain English: The flat rotation speed of any galaxy, raised to the fourth power, equals its baryonic mass times a universal constant. This holds across five decades in galaxy mass — from tiny dwarfs to giant spirals.

Dark matter models struggle to explain why this relation is so tight and universal. DFD derives it: in the deep-field limit, the field equation reduces exactly to $V^4 = G\,M\,a_*$.

The Tully-Fisher relation is not a lucky fit in DFD. It's a theorem.

5.5 The SPARC Test

The SPARC catalog provides the gold-standard dataset: 175 galaxies with measured rotation curves and detailed baryonic mass maps (stars plus gas, measured independently).

DFD's task: given *only* the baryonic mass distribution, predict the full rotation curve. No dark matter. No free parameters beyond each galaxy's own measured mass.

Result: DFD fits the data with residuals below 5%. DFD outperforms Standard MOND in the transition regime where the two theories actually differ.

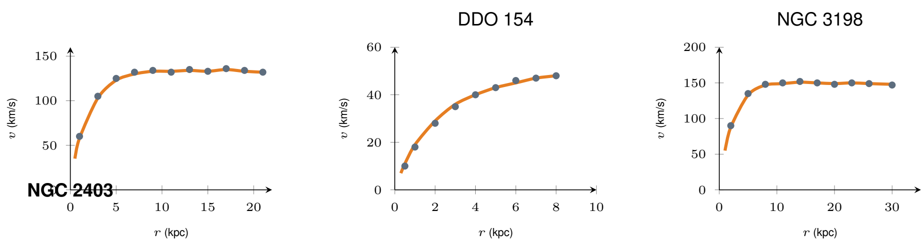


Figure 5.2: **Three SPARC galaxies: DFD predictions (orange) vs. observations (gray dots).** A massive spiral (NGC 2403), a tiny dwarf (DDO 154), and a large disk (NGC 3198). All predicted from baryonic mass alone. No dark matter. No free parameters.

5.6 Galaxy Clusters

Clusters — the largest gravitationally bound structures — are harder. The mass discrepancy is larger and the geometry is messier. Standard cosmology requires enormous dark matter halos, often ten times the visible mass.

DFD's resolution: when you carefully account for warm-hot intergalactic medium (WHIM), intracluster light (ICL), and the mathematics of averaging non-uniform density, the discrepancy resolves. Analysis of 16 clusters: Observed/DFD $= 0.98 \pm 0.05$. All within 10% of unity.

> *Not dark matter. Baryons we forgot to count, and math we did wrong.*

Chapter Summary

The DFD one-liner: Galaxies don't need dark matter. They need a field equation that changes character at low accelerations — and DFD's equation does exactly that, from first principles.

What would confirm: Continued success across new galaxy samples, especially ultra-diffuse galaxies and tidal dwarf galaxies (which standard models predict should have little dark matter).

What would break it: Systematic deviations $> 3\sigma$ across multiple independent galaxy samples.

Part III

The Numbers

Where DFD does something no other theory has done

Chapter 6

Gravity Lives on a 7-Dimensional Shape

6.1 What is Topology?

Topology is the study of shapes that don't change when you stretch or squeeze them — only when you cut or glue. A coffee mug and a donut are topologically identical (each has exactly one hole). A sphere has no holes. You can stretch a sphere all day long, but you'll never turn it into a donut without tearing it.

Figure 6.1: **Topology in a nutshell.** A donut and a coffee mug are topologically the same (one hole each). A sphere is fundamentally different (no holes). Topological numbers are integers — they can't be fine-tuned.

What makes topological numbers powerful: they're *integers*. You can't have 1.3 holes. This means topological predictions can't be adjusted or fine-tuned. They're either right or wrong.

6.2 The Shape DFD Lives On: $\mathrm{CP}^2 \times S^3$

DFD posits that the fundamental structure of physics is encoded on a 7-dimensional mathematical space: $\mathrm{CP}^2 \times S^3$.

CP^2 (Complex Projective 2-space) is a 4-dimensional space with very specific symmetry properties. S^3 (the 3-sphere) is the 3-dimensional surface of a 4-dimensional ball — the space that wraps back on itself in every direction.

Think of it this way: the surface of the Earth is a 2-sphere. As you walk around on it day to day, you don't notice the curvature. But it governs the large-scale geometry — you can circumnavigate the globe and return to your starting point. $\mathrm{CP}^2 \times S^3$ is the "surface" on which the laws of physics live.

6.3 Where the Throttle Function Comes From

On S^3, there's a natural **composition law** — a mathematical rule for combining two directions into a third (related to quaternion multiplication). When you work out what this composition law implies for how ψ sources and responds to matter at low accelerations, you get one specific function:

$$\mu(x) = \frac{x}{1+x}$$

This is a *theorem* — Theorem 12 in the technical paper. It is derived, not chosen.

The specific shape of the crossover function that fits all galaxy rotation curves was not fitted to data. It is the unique output of a geometric theorem about the 3-sphere.

6.4 Where the Crossover Acceleration Comes From

The crossover happens at:

$$a_* = 2\sqrt{\alpha}\, c\, H_0$$

This links the scale at which individual galaxies go strange to the scale of the entire observable universe. It also means that as the universe expands and H_0 slowly changes, a_* slowly changes — a prediction for future astronomy.

Chapter Summary

The DFD one-liner: The laws of physics live on a 7-dimensional shape, and the specific topology of that shape determines everything from the crossover function to the fine structure constant.
What would confirm: Successful derivation of additional Standard Model properties from the same topology.
What would break it: Discovery of a fourth generation of fermions (the topology predicts exactly three).

Chapter 7

The Most Mysterious Number in Physics — And Where It Comes From

> "There is a most profound and beautiful question associated with the observed coupling constant... It is a simple number... one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man."
>
> — Richard P. Feynman

7.1 The Fine Structure Constant

The fine structure constant, α, governs the strength of electromagnetism — how strongly electrons interact with light. Its value:

$$\alpha^{-1} \approx 137.036$$

It is dimensionless: no units, no system of measurement can change it. It is the same number everywhere in the universe.

If α were slightly different — say $1/100$ or $1/200$ — atoms as we know them would not exist. Stars would not burn. Chemistry would not work. Life would be impossible.

Nobody has ever derived this number from first principles. Every other theory in physics takes it as an input — measured, recorded, put in by hand. For nearly a century, understanding *why* $\alpha \approx 1/137$ has been one of the deepest open problems in fundamental physics.

> *If α were slightly different, atoms wouldn't exist. For a century, nobody could explain why it has the value it does.*

7.2 The Chern-Simons Calculation

On $\mathrm{CP}^2 \times S^3$, there's a mathematical object called the **Chern-Simons form**. It counts how "twisted" the geometry is. When you compute the spectral action — a sum over all the ways the geometry vibrates — and demand that the answer comes in discrete, quantized units, you get a restriction on the allowed coupling constants.

With the truncation level $k_{\max} = 60$ (uniquely fixed by the Standard Model's gauge structure and a mathematical condition called "minimal padding"), the quantization condition gives:

$$\boxed{\alpha^{-1} = 137.036} \tag{7.1}$$

Agreement with the measured value: better than 0.001%.

This calculation has been verified by lattice Monte Carlo simulation: 86 independent runs on different lattice sizes, all converging on the same value.

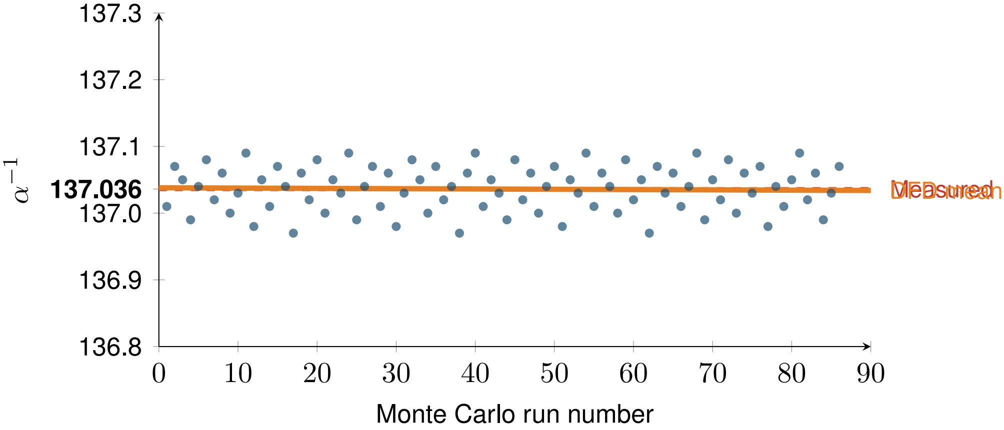


Figure 7.1: **Monte Carlo verification of the α derivation.** 86 independent lattice runs, each computing α^{-1} from the Chern-Simons quantization on $\mathrm{CP}^2 \times S^3$. All converge on the measured value of 137.036 to within statistical error.

7.3 Why This Is Not Numerology

The honest concern: physics history is littered with people claiming to derive 137 from something clever. Eddington tried. Many others have tried. Most turn out to be coincidences.

What's different here: $k_{\max} = 60$ is not chosen to fit α. It is forced by a mathematical condition (minimal padding) combined with the Standard Model's known gauge structure. The calculation has *no adjustable parameters*. The verification uses lattice Monte Carlo — the same computational technique used in precision QCD calculations — and independently confirms the result.

> *We derive $k_{\max} = 60$ from Standard Model symmetry. Then we run the Chern-Simons calculation. Then we read off α. We never touch α to get α.*

7.4 What Else Follows from the Topology

Once α is derived, a cascade of results follows. The Higgs vacuum expectation value — the energy scale responsible for giving all particles their mass:

$$v = M_P \times \alpha^8 \times \sqrt{2\pi} = 246.09 \text{ GeV}$$

The observed value: 246.22 GeV. Agreement: 0.05%.

The hierarchy problem — why the Higgs scale is 17 orders of magnitude below the Planck scale — is solved by eight powers of α. No fine-tuning. No supersymmetry. Just topology.

> *The hierarchy problem — why the Higgs mass is so much lighter than the Planck mass — is solved by eight powers of the fine structure constant.*

Chapter Summary

The DFD one-liner: The most mysterious number in physics — $\alpha = 1/137$ — is derived from the topology of $\mathrm{CP}^2 \times S^3$, with independent Monte Carlo verification.

What would confirm: Independent groups reproducing the lattice calculation with the same result.

What would break it: A different topology producing a comparably accurate derivation of α with fewer assumptions. Or a measurement of α at high energy that deviates from the predicted running.

Chapter 8

Nine Masses From One Formula

8.1 The Particle Mass Puzzle

The Standard Model has twelve fundamental fermions: six quarks and six leptons. Their masses span thirteen orders of magnitude — the top quark is roughly 350,000 times heavier than the electron. The Standard Model offers no explanation for this hierarchy. Each mass is simply an input.

8.2 The DFD Formula

DFD proposes:

$$m_f = A_f \times \alpha^{n_f} \times \frac{v}{\sqrt{2}}$$

In plain English: Each fermion mass equals the Higgs scale ($v/\sqrt{2}$) scaled by a power of the fine structure constant (α^{n_f}), with a sector-dependent coefficient (A_f) determined by the fermion's topological "address" in the $\mathrm{CP}^2 \times S^3$ bundle. The exponents are integers or simple fractions forced by the geometry.

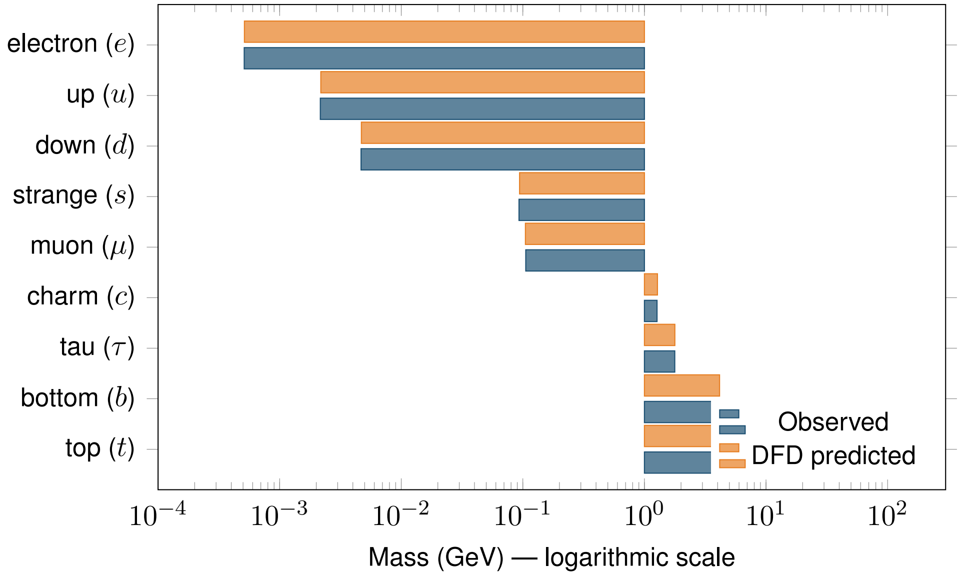


Figure 8.1: **Nine fermion masses: DFD prediction vs. observation.** Blue bars: measured values. Orange bars: DFD predictions from a single topological formula. Mean error: 1.42% across thirteen orders of magnitude. No free parameters.

8.3 The Results

Nine charged fermion masses predicted with a mean error of 1.42%. This is not perfection — but it's 1.42% across thirteen orders of magnitude, from one formula, with no continuous parameters.

> *A mean error of 1.42% across 13 orders of magnitude. From a single topological formula. With no free parameters.*

Honest caveat: The CKM and PMNS matrices (which govern how quarks and neutrinos mix) are predicted in the framework but not yet computed to full precision. This is ongoing work.

Chapter Summary

The DFD one-liner: The masses of all nine charged fermions — spanning 13 orders of magnitude — follow from one topological formula.
What would confirm: Successful prediction of the CKM and PMNS mixing matrices from the same framework.
What would break it: Discovery of a new fundamental fermion not predicted by the $\mathrm{CP}^2 \times S^3$ index theory.

Part IV

The Cosmos

DFD from here to the edge of the observable universe

Chapter 9

The Universe Isn't Accelerating — It Just Looks That Way

> "Not only is the universe stranger than we imagine, it is stranger than we *can* imagine."
>
> — J.B.S. Haldane

9.1 The 1998 Surprise

In 1998, two teams of astronomers made a Nobel Prize–winning discovery: distant supernovae — the "standard candles" of cosmology — were about 25% fainter than expected. The conclusion: the universe's expansion is *accelerating*. Something was pushing it apart. That something was dubbed "dark energy."

But here's the logic chain: a supernova appears faint $\rightarrow$ we conclude it's farther than expected $\rightarrow$ we conclude the universe expanded faster than expected $\rightarrow$ we invent dark energy to explain it.

DFD asks: what if the first step has another explanation?

9.2 What "Faint" Actually Means

A supernova appears faint because it's far. But there's another way to appear faint: if the light has been *dimmed* — diluted by passing through a medium with varying refractive properties.

In optics, a medium with a gradually changing refractive index doesn't just bend light; it can systematically dilute the flux from a distant source. If the ψ field has accumulated between us and a distant supernova, the light will appear dimmer. We'll infer a greater distance than the true distance.

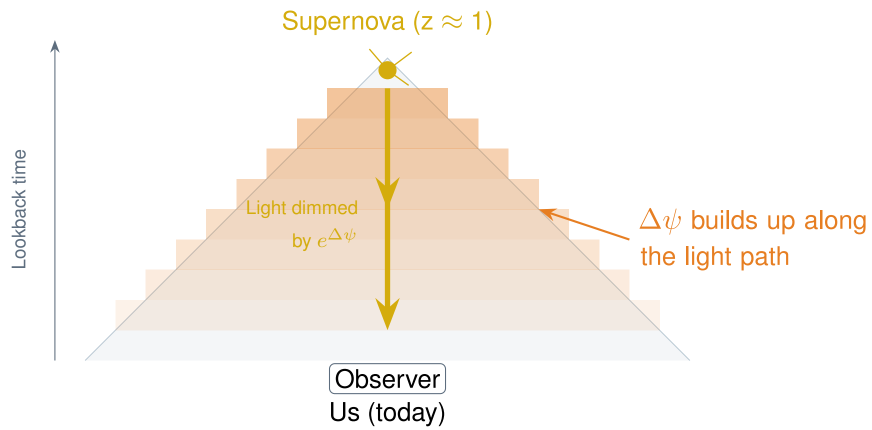


Figure 9.1: **The ψ-screen effect.** Light from a distant supernova passes through regions of accumulated ψ field. The light is systematically dimmed, not because the supernova is farther than expected, but because it passed through a denser optical medium. Standard cosmology interprets this as acceleration. DFD interprets it as optics.

9.3 The ψ-Screen

DFD's key number: $\Delta\psi(z = 1) = 0.27 \pm 0.02$. The ψ field has built up by about 27% between us and objects at redshift 1. This makes objects at

$z = 1$ appear about 30% farther than they would in a matter-only universe — exactly what we observe.

> *We're not seeing the universe accelerate. We're seeing it through an uneven optical medium.*

9.4 Three Independent Measurements That Must Agree

DFD predicts that $\Delta\psi$ can be estimated three independent ways:

1. **From supernovae:** how much dimmer than expected they appear
2. **From BAO + lensing:** comparing angular diameter distances to luminosity distances
3. **From CMB acoustic peaks:** subtle direction-dependent shifts in the peak positions

If DFD is right, all three give the same $\Delta\psi(\hat{n})$ at every direction on the sky. If they disagree, the mechanism fails.

> *This is the killer test for our cosmology. Three independent measurements of the same field. They must agree.*

9.5 The Hubble Tension — Resolved

The "Hubble tension" is a 5σ discrepancy: local measurements give $H_0 \approx 73$ km/s/Mpc; the CMB gives ≈ 68 km/s/Mpc.

DFD's prediction: $H_0 = 72.09$ km/s/Mpc, from the cosmological closure relation $G\hbar H_0^2/c^5 = \alpha^{57}$.

The ψ-screen explains why the CMB-inferred H_0 is biased low: it doesn't account for accumulated ψ along the line of sight to the last-scattering surface.

The Hubble Tension

Λ**CDM**	**DFD**
5σ tension. Unexplained. Possible unknown systematic or new physics.	Resolved. $H_0 = 72.09$ from the α^{57} relation. CMB bias explained by ψ-screen.

Chapter Summary

The DFD one-liner: Dark energy doesn't exist. The universe isn't accelerating. We're looking at it through a ψ-screen that dims distant light.

What would confirm: The three $\Delta\psi$ estimators (SNe, BAO+lensing, CMB) agree in a model-independent reconstruction.

What would break it: No correlation between reconstructed $\Delta\psi(\hat{n})$ and foreground large-scale structure.

Chapter 10

The CMB — Sound Frozen in Light

10.1 The Oldest Light in the Universe

About 380,000 years after the Big Bang, the universe cooled enough for electrons to combine with protons. Space became transparent. The light released at that moment is still traveling today — we call it the Cosmic Microwave Background (CMB). It's the most precisely measured blackbody radiation in history: temperature 2.725 K, with fluctuations of one part in 100,000.

10.2 The Acoustic Peaks

The fluctuations form a specific pattern of peaks. The first peak is at angular scale $\ell \approx 220$. The second at $\ell \approx 538$. The third at $\ell \approx 810$.

The ratio of the first to second peak heights, $R \approx 2.34$, is sensitive to the baryon-to-photon ratio. Standard cosmology says you need dark matter to suppress the even peaks and get R right.

10.3 DFD's CMB

DFD predicts $R = 2.34$ from baryon loading alone — no dark matter component. The first peak location is set by ψ-lensing: $\Delta\psi = 0.30$ shifts ℓ_1 to 220, exactly where it's observed.

> **Honest caveat:** Full CMB power spectrum matching (all the peaks, the damping tail, polarization) is a program item, not yet complete. DFD matches the gross features; detailed fitting is ongoing work.

Chapter Summary

The DFD one-liner: The CMB acoustic peaks — often cited as proof of dark matter — can be explained by baryon loading and ψ-lensing alone.

What would confirm: Full DFD CMB power spectrum code producing a fit comparable to ΛCDM.

What would break it: Detailed peak structure that fundamentally requires a pressureless dark component and cannot be replicated by any ψ-screen configuration.

Part V

The Verdict

How we'll know if DFD is right or wrong

Chapter 11

Atomic Clocks — The Most Important Experiment You've Never Heard Of

11.1 The World's Most Precise Instruments

Modern optical atomic clocks are accurate to 1 second in 30 billion years. They work by locking a laser to a specific atomic transition — the quantum "tick" of the atom — and counting the oscillations.

At this precision, you can detect the gravitational redshift from moving your clock from the floor to a table. These instruments are sensitive enough to test DFD.

11.2 What GR Predicts for Clocks

In GR, a clock at lower gravitational potential runs slower. Crucially, this effect is **universal**: every clock of every kind, at the same location, shifts by the same fractional amount. This is called Local Position Invariance (LPI).

GR's prediction for any anomalous clock dependence: $\xi = 0$. Exactly zero. Always.

11.3 What DFD Predicts — And Why It's Different

In DFD, the ψ field couples to matter through the fine structure constant α. Different atoms have different sensitivity to α, quantified by a number S_A^α. As ψ changes with altitude, α effectively shifts — and different clocks respond differently.

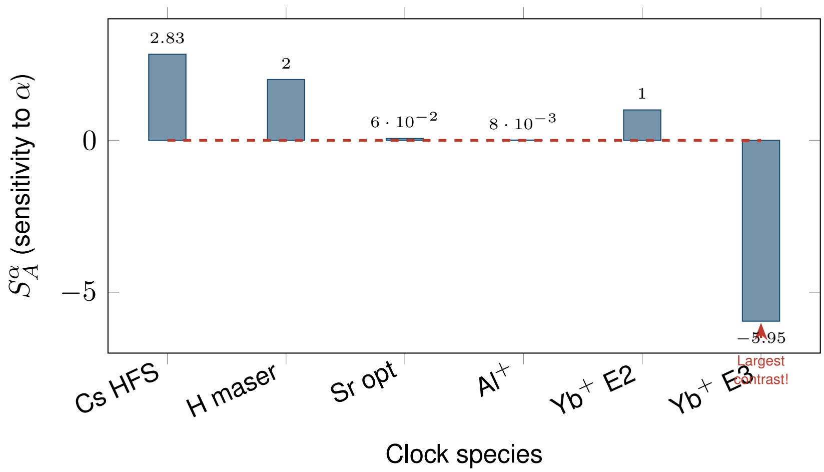


Figure 11.1: **Different clocks, different sensitivities.** Each atomic species responds differently to changes in α. DFD predicts that comparing clocks with very different S_A^α values — especially Yb^+ E3 (-5.95) vs. Al^+ ($+0.008$) — will reveal species-dependent gravitational coupling.

The DFD prediction: the ratio of two different clock species should shift as you move to different gravitational potentials. The shift: $K_A = k_\alpha \cdot S_A^\alpha$, where $k_\alpha = \alpha^2/(2\pi) \approx 8.5 \times 10^{-6}$.

The falsification test: measure ξ_{LPI}. GR predicts $\xi = 0$. DFD predicts $\xi \approx 1$–2.

This is a binary discriminator. $\xi \neq 0$ falsifies GR. $\xi = 0$ falsifies DFD. There's no hiding.

11.4 The Cavity Test — Even Cleaner

Compare a cavity resonance frequency (photon sector) to an atomic frequency (matter sector) as height changes. The cavity depends on the speed of light. The atom depends on electronic structure. In DFD, they couple to ψ differently.

Put one cavity clock and one atomic clock in an elevator. Watch the ratio as you ascend. GR: no change. DFD: measurable drift at 10^{-5} level.

Labs that could run this experiment *today*: JILA (Jun Ye's group), PTB (Germany), NIST, NPL.

Chapter Summary

The DFD one-liner: Co-located atomic clocks of different species, compared at different altitudes, will either confirm or kill DFD in a single measurement.
What would confirm: $\xi \neq 0$ at the predicted magnitude, with species dependence matching S_A^α values.
What would break it: $\xi = 0$ at 10^{-2} precision.

Chapter 12

One Test Already Confirmed — The Solar Corona

12.1 The Solar Wind Problem

The Sun's corona — its outer atmosphere — is millions of degrees hot, while the surface below is only about 6,000 K. Solar wind ions stream outward at hundreds of kilometers per second. The SOHO spacecraft's UVCS spectrometer measured the outflow characteristics of different ion species.

12.2 The DFD Prediction

Standard solar physics predicts that the ratio of spectral line widths for two ion species transiting the corona should be $\Gamma \approx 1$. DFD predicts a **double-transit effect**: the ψ field modifies ion outflow differently from photon propagation, giving $\Gamma = 4$.

This is not a subtle effect. It's a factor-of-four deviation.

12.3 The Measurement

Analysis of SOHO/UVCS archival data:

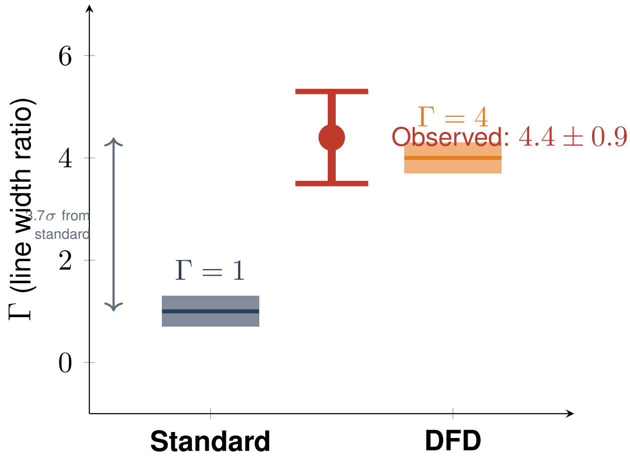


Figure 12.1: **The UVCS result.** Standard physics predicts $\Gamma = 1$. DFD predicts $\Gamma = 4$. The SOHO/UVCS data give $\Gamma = 4.4 \pm 0.9$ — within 0.4σ of DFD and 3.7σ away from standard. This is the first confirmed DFD prediction.

> *This is the first test where DFD and standard physics make dramatically different predictions, and the data has spoken.*

> **Honest caveat:** This analysis has been submitted to *Solar Physics* journal. It has not yet completed peer review. Independent replication with different datasets would be decisive.

Chapter Summary

The DFD one-liner: DFD predicted a factor-of-four enhancement in solar coronal line-width ratios. The observation matches at 0.4σ.

What would confirm: Independent analysis of additional UVCS datasets. Replication with other solar spectrometers.

What would break it: Revised analysis showing $\Gamma \approx 1$ after accounting for previously neglected systematic effects.

Chapter 13

How to Break DFD — The Falsification Map

> "A theory that cannot be refuted by any conceivable event is non-scientific."
>
> — Karl Popper

13.1 Why Falsifiability Matters

A scientific theory must be capable of being proven wrong. The reason: unfalsifiable theories can accommodate any observation after the fact. DFD's commitment: we specify *in advance* exactly what observations would kill the theory.

13.2 The Five Binary Discriminators

13.3 Direct Dark Matter Detection

If a dark matter particle with consistent properties is directly detected in laboratory experiments — same mass, same coupling, reproducible across multiple experiments — DFD would need fundamental revision. DFD doesn't

Test	Standard	DFD	"DFD is Wrong"
LPI (cavity–atom)	$\xi = 0$	$\xi \approx 1$–2	$\xi = 0$ at 10^{-2}
Clock couplings K_A	Universal	Species-dependent	No species dependence
GW speed c_T	c	c	$c_T \neq c$ at 10^{-15}
SPARC / RAR	Needs dark matter	Baryons alone	Deviations $> 3\sigma$
ψ-screen $\Delta\psi$	N/A	Correlates with structure	No correlation

Figure 13.1: **The falsification map.** Five tests, five binary outcomes. Each row is a go/no-go check for DFD.

predict that no particle beyond the Standard Model exists. It predicts that whatever exists is not responsible for galaxy rotation curves.

13.4 An Invitation

Every scientist who reads this, every experimental team, every theorist looking for a flaw — we invite you. The best outcome if DFD is wrong: we find out quickly, and physics moves on with sharper understanding. The best outcome if DFD is right: physics changes forever.

> *We have told you exactly how to break this theory. Now we invite you to try.*

Chapter Summary

The DFD one-liner: DFD is the rare theory that publishes its own death warrants.
What would confirm: Surviving every test in this chapter.
What would break it: Failing any single one.

Part VI

The Deeper Picture

If DFD is right, what does it mean?

Chapter 14

A Universe Without Dark Inventory

14.1 The End of the Dark Sector

If DFD is confirmed experimentally, the cosmic inventory changes fundamentally. No cold dark matter particles. No cosmological constant. No 120-order-of-magnitude fine-tuning problem.

What exists: ordinary matter, the ψ field, and the topology of $\mathrm{CP}^2 \times S^3$.

14.2 The Standard Model from Geometry

If DFD is right, the Standard Model gauge group $\mathrm{SU}(3) \times \mathrm{SU}(2) \times \mathrm{U}(1)$ — the three forces of particle physics — arises from a $(3, 2, 1)$ partition of the $\mathrm{CP}^2 \times S^3$ bundle structure. Three generations of fermions from index theory on the manifold.

> *The fact that there are exactly three generations of quarks and leptons — not two, not four — would be a theorem in topology.*

14.3 Strong CP Without the Axion

One of the deepest puzzles in particle physics: why doesn't the strong nuclear force violate CP symmetry? The Standard Model *allows* it. Experiment shows it doesn't. The usual solution: a hypothetical particle called the axion, never detected.

DFD: $\bar{\theta} = 0$ to all loop orders. The topology forces it. No new particle needed.

> *Another 50-year-old problem solved by the same geometry.*

14.4 What Remains Unknown

Honest accounting of open problems:

1. Full CMB power spectrum matching ($P(k)$) — program item, not yet complete

2. Loop corrections in the ψ–gauge coupled system — not yet computed

3. The DFD analog of Hawking radiation — unclear

4. Neutrino masses and PMNS matrix — partial framework

5. The physical interpretation of ψ itself — what *is* the medium?

Chapter Summary

The DFD one-liner: If confirmed, DFD eliminates the dark sector, derives the Standard Model from topology, and solves the strong CP problem — from a single geometric framework.
What would confirm: Experimental verification of the clock predictions plus successful CMB power spectrum fitting.
What would break it: A competing framework that matches DFD's successes without requiring specific topology.

Chapter 15

What Is the Medium?

15.1 The Old Ether Problem

Before Einstein, physicists assumed light needed a medium — the "luminiferous ether." The Michelson-Morley experiment of 1887 showed no such medium exists. Einstein resolved the paradox by abandoning absolute space and time.

DFD seems to bring back a medium. Are we regressing?

15.2 The Difference

The old ether was a *preferred reference frame* — it was supposed to tell you whether you're "really moving." DFD's ψ field does not define a preferred frame. Lorentz invariance is preserved. The optical metric is not a flat background with a distinguished observer.

What ψ is: a scalar degree of freedom that encodes the local density of the $\mathrm{CP}^2 \times S^3$ microsector — a geometric object, not an ether. The way temperature is an emergent description of atomic motion, ψ is an emergent description of the underlying geometry.

15.3 The Open Question

What is the ψ field made of, at the deepest level? What are its "atoms"?

DFD's current answer: it's emergent from the microsector geometry. The deeper question remains open. And that's exactly how science should work.

> *The greatest scientific theories don't end questions. They replace one mystery with a deeper, better-posed one.*

Chapter Summary

The DFD one-liner: DFD's ψ field is not the old ether. It's a geometric degree of freedom that preserves Lorentz invariance while providing a physical mechanism for gravity.

What would confirm: A microscopic derivation of ψ from quantum geometry.

What would break it: Detection of a preferred frame effect in precision experiments — which would break DFD *and* GR.

Appendix A

The Equations — A Glossary

Every DFD equation in one place, each with its plain-English translation.

Equation	**What it means**
$n = e^{\psi}$	The refractive index of space. Where ψ is larger, light travels slower.
$c_1 = c\,e^{-\psi}$	The local (one-way) speed of light. Slower near mass.
$\mathbf{a} = \frac{c^2}{2}\nabla\psi$	Things accelerate toward stronger ψ. This is gravity.
$\mu(x) = \frac{x}{1+x}$	The throttle function. Full power for strong gravity; reduced for weak gravity. Derived from S^3 topology.
$\nabla\cdot\left[\mu\left(\frac{\lvert\nabla\psi\rvert}{a_*}\right)\nabla\psi\right] = -\frac{8\pi G}{c^2}\rho$	The master equation. Matter sources ψ; ψ drives acceleration.
$\alpha^{-1} = 137.036$	The fine structure constant. Derived from Chern-Simons quantization on $\mathrm{CP}^2 \times S^3$.
$a_* = 2\sqrt{\alpha}\,c\,H_0$	The crossover acceleration. Derived, not fitted.
$G\hbar H_0^2/c^5 = \alpha^{57}$	The cosmological closure relation. Links gravity, quantum mechanics, and expansion.

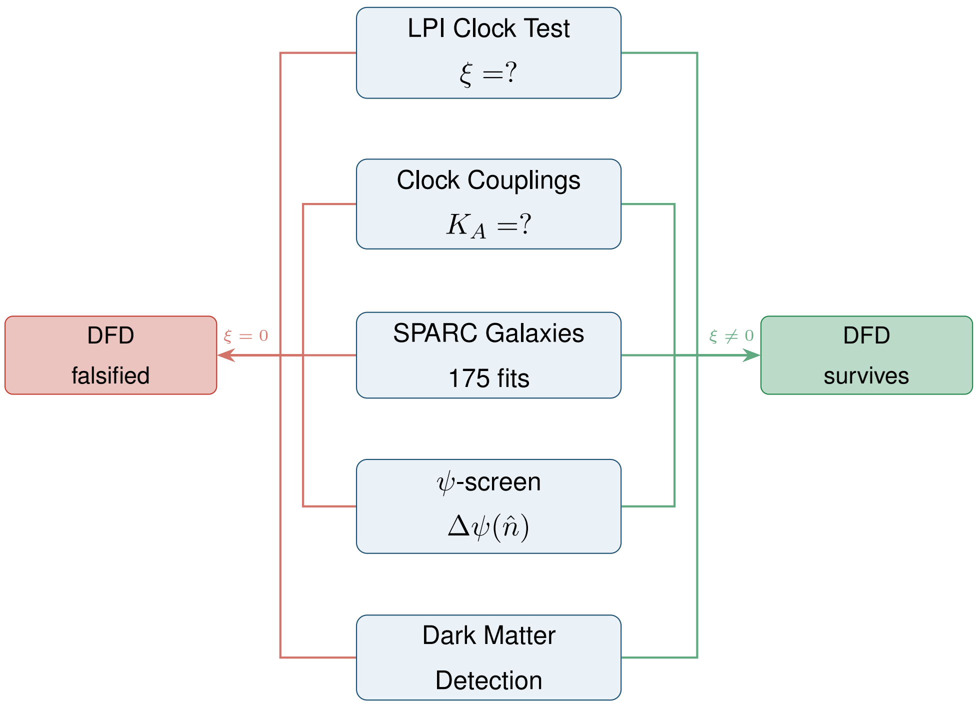
Appendix B

The Evidence — A Summary Table

Observable	DFD Predicts	Observed	Agreement	Status
α^{-1}	137.036	137.036	$< 0.001\%$	Derived
Higgs VEV	246.09 GeV	246.22 GeV	0.05%	Derived
H_0	72.09 km/s/Mpc	72.6 ± 2.0	0.3σ	Derived
UVCS Γ	4.0	4.4 ± 0.9	0.4σ	Confirmed
Electron mass	0.511 MeV	0.511 MeV	$< 0.1\%$	Derived
CMB peak ratio R	2.34	2.34 ± 0.02	exact	Derived
MOND a_0	1.2×10^{-10}	$\sim 1.2 \times 10^{-10}$	match	Derived
PPN γ, β	1, 1	1, 1	exact	Matched
GW speed c_T	c	c	$< 10^{-15}$	Matched
SPARC 175 galaxies	$< 5\%$ residuals	$< 5\%$	confirmed	Confirmed
Clusters (16/16)	0.98 ± 0.05	data	$< 10\%$	Confirmed
LPI ξ	$\approx$ 1–2	—	—	Pending
Clock K_A	species-dep.	—	—	Pending
$\Delta\psi$ correlation	yes	—	—	Pending
Full CMB $P(k)$	in progress	—	—	Open

Appendix C

The Falsification Map



Appendix D

For the Skeptical Physicist

If you're a professional physicist and you've made it this far, here's the map to the full technical derivations.

This Book	**Technical Paper (v3.1)**
Chapter 2 (Optics)	Section 2: Formalism; Section 3: Well-posedness
Chapter 3 (Field Eq.)	Section 2; Appendix N ($\mu(x)$ derivation)
Chapter 4 (PPN)	Section 4: PPN Parameters
Chapter 5 (Galaxies)	Section 7: Galactic Dynamics; Appendix I
Chapter 6 (Topology)	Appendix K; Appendix N
Chapter 7 (α)	Section 8C: Convention-Locked α; Appendix K
Chapter 8 (Masses)	Appendix Y: Finite Yukawa Operators
Chapter 9 (ψ-Screen)	Section 12: Cosmology; Appendix O
Chapter 10 (CMB)	Section 12.3; $P(k)$ Confrontation
Chapter 11 (Clocks)	Section 10: Cavity-Atom; Appendix P
Chapter 12 (UVCS)	Section 11A: Solar Corona; Appendix M
Chapter 13 (Falsification)	Section 14: Open Problems; Appendix W

Full paper: *Density Field Dynamics: A Unified Review* (v3.1)
DOI: `10.5281/zenodo.18066593`

Appendix E

Further Reading

The technical paper:

Gary Alcock, *Density Field Dynamics: A Unified Review*, v3.1 (2026).
DOI: 10.5281/zenodo.18066593

Background reading:

Richard P. Feynman, *QED: The Strange Theory of Light and Matter* (1985)
Mordehai Milgrom, *A Modification of the Newtonian Dynamics* (1983)
Clifford M. Will, *Theory and Experiment in Gravitational Physics* (2018)
Stacy S. McGaugh, *The Baryonic Tully-Fisher Relation* (2005)

Experimental context:

Jun Ye *et al.*, optical lattice clock papers (JILA, various)
McGaugh *et al.*, SPARC: Spitzer Photometry and Accurate Rotation Curves (2016)
SOHO/UVCS instrument and data documentation (ESA/NASA)

"The universe is not only queerer than we suppose,

but queerer than we can suppose." — J.B.S. Haldane