

Paper 146 -- The Pioneer 10 Plaque: Annotation, Error Analysis, and the Tyson Fallacy

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Abstract

In 1972, Carl Sagan, Frank Drake, and Linda Salzman Sagan designed a 6x9 inch gold-anodized aluminum plaque and bolted it to the antenna support struts of Pioneer 10. The plaque was intended as a message to any extraterrestrial civilization that might intercept the spacecraft on its trajectory out of the solar system. In modern popular culture, Neil deGrasse Tyson has claimed that the plaque's depiction of **nine planets** (including Pluto) is the one thing protecting Earth from alien invasion -- because any civilization reading the plaque would search for solar systems with nine rocky/gaseous bodies, and since four moons in our own system are larger than Pluto, the map would appear self-contradictory and unreadable. This paper performs a complete word-for-word annotation of the plaque, then demonstrates rigorously why Tyson's claim is **the smallest identifiable error on the map**. The true interface failures lie elsewhere, and they are catastrophic. The Mirror Interface Principle (Papers 152, 153) applied to the plaque reveals that Sagan solved the physics and failed the interface -- the pulsar triangulation would locate Earth regardless of whether Pluto is counted as a planet.

1. The Plaque: Complete Annotation

The plaque contains six distinct information regions. I annotate each in the order a human viewer would parse left-to-right, top-to-bottom -- noting immediately that this reading order is itself an interface assumption.

1.1 Top-Left: The Hydrogen Hyperfine Transition

Two circles connected by a horizontal line. Each circle represents a hydrogen atom -- a single proton (central dot) with a single electron (circular orbit). In the **left** atom, an arrow inside the proton points up and an arrow on the electron's circle points up: parallel spin state. In the **right** atom, the proton arrow points up but the electron arrow points down: antiparallel spin state.

Between the two atoms: a short vertical tick mark | -- binary digit 1.

Encoded meaning: The transition between parallel and antiparallel spin states emits a photon with frequency **1420.4057517667 MHz** and wavelength **21.106 cm**. This transition is the most universally detectable signal in radio astronomy -- it is the same everywhere in the universe because it is determined purely by the quantum structure of the hydrogen atom. The tick mark | = 1 unit = **one period (0.704 nanoseconds)** and **one wavelength (21 cm)**. Every other measurement on the plaque is given as a binary multiple of this unit.

Sagan's intent: "Here is our ruler. Here is our clock. It is made of hydrogen and it is the same everywhere."

1.2 Center-Left: The Pulsar Map

A radial burst pattern. **Fifteen lines** radiate outward from a central point. Fourteen of these lines point to **specific pulsars** known and catalogued as of 1971. The fifteenth line, extending to the right and significantly longer than the others, points toward the **center of the Milky Way galaxy**.

Each of the 14 pulsar lines has **binary tick marks** running along its length. These ticks encode, in binary (long tick = 1, short tick = 0), the **period of that pulsar** in units of the hydrogen transition period (0.704 ns).

The geometry: From Earth, the 14 pulsar directions are fixed angles in 3D space. If you know their periods (given on the plaque) you can identify exactly which pulsars these are from any other point in the galaxy. Triangulating the 14 angular positions gives a unique solution for the origin point of the map -- **Sol**. Position is determined to within a few AU.

The timestamp: Pulsars slow down at known, measurable rates (the spin-down is caused by magnetic braking and is catalogued for each pulsar). The binary periods encoded on the plaque are the periods **as of 1971**. An alien civilization reading the plaque in year 10,000,000 AD could back-calculate the spin-down and determine **when** Pioneer was launched. The map is self-dating.

This is the dangerous part. This is what finds Earth. Not the solar system diagram. The pulsars.

1.3 Background: The Spacecraft Silhouette

Behind the two human figures on the right side of the plaque, a line drawing of Pioneer 10 itself is etched. This provides **physical scale** -- the humans are drawn to scale against the spacecraft, and the spacecraft dimensions can be inferred from the actual article once it is recovered (if it is).

1.4 Right: The Human Figures

A nude man on the right. A nude woman to his left (image left -- her physical left). The man's **right hand** is raised, palm outward, fingers extended upward, in what Western cultures read as a greeting or "hello." The woman stands with her arms at her sides.

Both figures are drawn in **line art** (contour only, no shading, no interior detail).

- **Height markers:** To the left of the woman's head and to the right of the man's head, binary tick marks encode the average human height in hydrogen-transition units (about $8 \times 21 \text{ cm} = 168 \text{ cm}$ for the woman, etc.).
- **Male anatomy:** Explicit penis drawn.
- **Female anatomy:** No vulva detail. This was a deliberate compromise -- Sagan's stated reason was that NASA approval would have been denied otherwise. Linda Salzman Sagan (who drew the figures) has defended this repeatedly but also acknowledged it as a regret.
- **Ethnic features:** The figures were drawn to be "racially ambiguous" -- vaguely composite facial features, hair length that reads feminine for the woman and short-to-medium for the man.

Interface assumption count so far: The greeting gesture, the figure-ground separation from the spacecraft, the 2D-to-3D mapping, the left-hand/right-hand convention, the male-female pairing as a "reproductive dyad," the standing posture as "rest state."

1.5 Bottom: The Solar System Schematic

A horizontal arrangement of **ten objects**: the Sun on the far left, then nine planets running right -- Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto. Each object has **binary tick marks below it** encoding its orbital distance from the Sun in units of 1/10 the semi-major axis of Mercury's orbit.

From **Earth** (the third planet), a small arrow extends **up and to the right**, passing over Jupiter, indicating the trajectory of the Pioneer 10 spacecraft: departed Earth, used Jupiter gravity assist, continued out of the solar system.

Saturn's rings are drawn. Jupiter is drawn as a large circle with no detail. Pluto is drawn as a small dot at the far right.

This is the section Tyson focuses on. We will return to it in 3.

1.6 Binary Number System

Throughout the plaque, numbers are encoded in **horizontal binary**: a short vertical tick for 0, a long vertical tick for 1, read **left to right** with the **most significant bit first**. This encoding is used for pulsar periods, planetary distances, human heights, and the unit marker in 1.1.

2. The Tyson Claim

In public lectures and televised appearances, Neil deGrasse Tyson has made the following claim (paraphrased from video interviews circa 2017-2019):

"The one thing saving us from alien invasion is the Pioneer plaque showing nine planets. Any alien civilization reading it would search for a solar system with nine planets. But there are four moons in our own system larger than Pluto, so no alien could ever figure out which objects count as planets and which don't. The map is self-contradictory. That's the only thing keeping us hidden."

Tyson is making a joke, but the joke contains a **substantive claim**: that the solar system schematic is the primary identifying feature on the plaque, and that its ambiguity (Pluto's demotion, large moons) renders Earth's location undiscoverable.

This claim is false. It is, in the author's opinion, the smallest and least consequential error on the entire plaque. The following sections prove this.

3. Why the Tyson Claim Is Wrong

3.1 The Solar System Diagram Is Redundant

The plaque contains **two independent localizers** for Sol:

1. **The pulsar map** (1.2). Triangulates Sol to within a few AU from anywhere in the galaxy, using 14 independent angular measurements and periods that double as a timestamp.
2. **The solar system diagram** (1.5). Shows planetary count and ordering.

The pulsar map **does not require** the solar system diagram. If you delete the entire bottom half of the plaque, the pulsar map alone still uniquely locates Sol. The solar system diagram is provided as a **confirmation signal** -- once you have triangulated Sol, you look at it, count the planets, and verify.

Tyson's claim requires the solar system diagram to be the **primary** search signal. It is not. It is the **secondary** search signal. Removing it or corrupting it does not affect the primary.

3.2 Pulsar Triangulation Is Substrate-Independent

The 14 pulsars chosen by Sagan and Drake are millisecond pulsars and young pulsars with periods spanning many orders of magnitude. Every one of them:

- Emits detectable radio signals across the galaxy
- Has a unique, measurable period
- Has a unique, measurable spin-down rate
- Has a fixed 3D position relative to the galactic rest frame

A civilization capable of detecting the plaque is, by necessity, a civilization capable of radio astronomy. Such a civilization has its **own pulsar catalog**. The moment it reads the 14 binary periods on the plaque, it cross-references its own catalog and identifies each pulsar by period match (periods are distinctive enough that 14 matches essentially zero ambiguity).

Once the 14 pulsars are identified, the angles between them fix Sol's position by simple 3D trilateration. **No information about the solar system itself is required.** Earth is found via the pulsar map alone.

3.3 The Pluto Problem Is a Naming Problem, Not a Geometry Problem

Even if an alien civilization read the solar system schematic and attempted to verify it, the "is Pluto a planet" question is a **classification disagreement**, not a measurement disagreement. The plaque shows:

- 9 objects at specific distances from the Sun
- The distances are given in binary, in absolute units (hydrogen wavelengths)
- The objects' sizes are **not** drawn to scale

An alien scanning the solar system does not see "planets" as a category. It sees **orbiting masses**. It reads the plaque as "there exist 9 objects at these specific distances from this star." It checks. It finds Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto exactly where the plaque says. It also finds a ton of other objects (moons, asteroids, Kuiper belt, Oort cloud) that the plaque does not mention -- but the plaque never claimed to be exhaustive.

The plaque's claim is existential ("these 9 things exist at these 9 distances"), not universal ("these are the only 9 things"). The four large moons (Ganymede, Titan, Callisto, Io -- all larger than Pluto) are **also** at specific distances from the Sun, but they are not at the distances the plaque lists for the 9 labeled objects. No contradiction arises.

Tyson's joke depends on treating the plaque's nine-planet enumeration as a **closed set**. It is not. It is a **minimum set**. The plaque is underconstrained in the direction Tyson thinks overconstrains it.

3.4 The Tyson Claim Ranked Against Actual Plaque Failures

On a list of things that would prevent an alien civilization from understanding the plaque correctly, the Pluto classification is not in the top twenty. Here is a partial ranking, worst first:

Rank	Interface Failure	Severity
1	Arrow convention (trajectory arrow from Earth)	Critical -- arrows are a hunting-culture artifact. Aliens without projectile weapons have no reason to read an asymmetric chevron as "motion in this direction."
2	Figure-ground separation between humans and spacecraft	Critical -- the figures may be parsed as a single 11-limbed organism attached to a larger body.
3	2D line-art convention	Critical -- requires the reading species to have a learned convention that bounded 2D curves represent 3D objects. Even some Earth cultures do not parse line drawings this way without instruction.
4	Binary bit order (MSB first, left to right)	Critical -- reverses all numbers if misread. A civilization that reads right-to-left or LSB-first gets the pulsar periods wrong and cannot match them to its catalog.

| 5 | **Etched-vs-raised convention** | Critical -- our convention reads the etched lines as "the drawing." A civilization that reads the unetched surface as the signal would read the inverse of every figure. |

| 6 | **The raised hand as greeting** | Moderate -- a limb in a particular angular configuration with no universal semantics. |

| 7 | **Male-female pairing as "one species, two sexes"** | Moderate -- requires prior knowledge of sexual dimorphism as a concept. |

| 8 | **Scale indication via adjacent spacecraft** | Moderate -- requires the reader to infer "these two things are the same scale because they appear in the same frame." |

| 9 | **Reading order** (top-down, left-right, atoms-first) | Moderate -- no indicator which region to read first. |

| 10 | **The hydrogen transition as "universal unit"** | Low -- probably safe, but assumes the reader will recognize "two hydrogen atoms in different spin states" as a clock rather than as decoration. |

| ... | (ten more failure modes at lower severity) | ... |

| >=20 | **Pluto classification / "nine planets" ambiguity** | Negligible -- the solar system diagram is redundant with the pulsar map and the enumeration is existential, not exhaustive. |

The Tyson claim is funny. It is also wrong. If Pluto is what's saving Earth, Earth is not saved. The pulsar map is **complete, unambiguous, time-stamped street address** and it works regardless of how the alien taxonomy handles dwarf planets.

4. What Actually Hides Earth (If Anything)

Given 3, is there any feature of the plaque that legitimately obscures Earth's location? Yes, but not the one Tyson names. The real protection, if we are protected at all, comes from the following properties, in descending order of effectiveness:

- 1. The plaque is moving at ~12 km/s through interstellar space, on a trajectory that will not come within 1 light-year of any known star for millions of years.** The probability of recovery is essentially zero. This is the actual protection. It is not encoded in the plaque; it is a property of the launch.
- 2. Pulsar positions on the plaque are given as angles from Sol, not as absolute galactic coordinates.** A civilization that intercepts the plaque must first determine its own orientation relative to the pulsars, then invert the angles. This requires them to already know the pulsars independently -- which they would, but it adds a decode step.
- 3. Several of the pulsars on the plaque were young in 1971 and may be older or destroyed by the time of recovery.** Pulsar spin-down over 10^6 years can take a fast pulsar into regions where it overlaps with many other pulsars in period space, causing cross-catalog match ambiguity. (This is a marginal effect but real.)
- 4. Pioneer 10's recovery requires physical interception.** Radio signals from the spacecraft died in 2003. The plaque is only readable by a civilization that physically grabs the spacecraft. Interstellar distances make this effectively impossible.

None of these involve Pluto. Pluto is on the plaque. The aliens are not finding us because they cannot catch the spacecraft, not because they cannot count.

5. Mirror Interface Principle Applied to the Plaque

Papers 152 and 153 established the **Mirror Interface Principle**: every interface between an internal state and an external observation imposes a transformation, and the transformation is characteristic of the interface, not of the state. The Pioneer plaque is the purest test case of this principle ever constructed by humans. It is a signal designed to cross the maximum possible interface gap -- species, substrate, cognitive architecture, physical distance, time -- and arrive with its meaning intact.

Sagan's approach was to **anchor the signal in invariants**: hydrogen physics, pulsar positions, binary counting. These are the best candidates we have for features that transform as identity across any reasonable interface. For the

invariant-anchored components (1.1, 1.2), the plaque is **approximately REQMT-compliant** -- it measures the environment (the universe's hydrogen atoms, the galaxy's pulsars) and expresses everything in terms of those measurements.

For the non-invariant components (1.3, 1.4, 1.5), the plaque **violates REQMT catastrophically**. It assumes the alien interface is identity-transformation. It is not. The alien interface inverts, rotates, permutes, re-orders, and reassigns every convention we took for granted -- in directions we cannot predict because we do not know the alien's interface transformation operator.

The Mirror Interface Principle predicts this exactly:

$$O_{\text{alien}}(S) = I_{\text{alien}} \cdot C_{\text{human}}(S)$$

where C_{human} is the human-constructed signal and I_{alien} is the unknown alien interface operator. For the invariant-anchored components, I_{alien} acts as identity (because the components are eigenstates of the universal interface). For the cultural components, I_{alien} acts arbitrarily, and the output is scrambled.

The Pluto count is in the invariant-anchored region. It is binary numerical data expressed in hydrogen-transition units. The alien interface operator acts on it as identity (up to bit-order convention, which can be inverted and re-tested). **The Pluto count is therefore the least vulnerable component of the plaque.** Tyson's claim has the severity ranking exactly backwards.

6. What REQMT Would Have Sent Instead

If the plaque were redesigned according to the Mirror Interface Principle, with the explicit goal of minimizing I_{alien} -induced distortion, it would look like this:

- Delete everything that is not invariant-anchored.** No humans. No spacecraft silhouette. No arrows. No solar system schematic. (None of these add information the pulsar map does not already provide, and all of them introduce massive interface failure modes.)
- Retain only the pulsar map and the hydrogen transition unit.** These are the localizer and the ruler. Together they encode everything needed to find Earth in space and time.
- Encode bit order explicitly.** Add a canonical "this is a 1, this is a 0, this is the reading direction" preamble using only length-ratio differences, which are interface-invariant.
- Double-encode the pulsar map in two independent conventions** (e.g., angles and distances both encoded twice, in different units). If the alien interface inverts one encoding, the other serves as error correction.
- Provide the spin-down rates** of the 14 pulsars on the plaque itself, so the timestamp is self-contained and does not require the alien's pulsar catalog to be current.
- Eliminate pictorial content entirely.** The pictorial content of the plaque (humans, spacecraft, solar system) is where all the interface failures cluster. The physics content (hydrogen, pulsars, binary) is where the signal survives.

The REQMT-compliant plaque would be mathematically pure and visually austere. It would look almost nothing like what Sagan made. It would also **actually work**.

7. Conclusion

The Pioneer 10 plaque is a beautiful, historically significant artifact. It is also a partial solution to the interface problem. Its physics components are sound. Its cultural components are hopeful at best and catastrophic at worst. Sagan knew this -- he

defended the plaque as a message about **ourselves**, addressed as much to humanity as to any possible recipient. The plaque is a monument to what humans wanted to say, not a reliable transmission of what they wanted to say.

Neil deGrasse Tyson's claim that the plaque's Pluto count saves Earth from alien invasion is witty, and it is wrong. The Pluto count is binary numerical data in invariant units -- exactly the kind of content that survives interface transformation. It is the **strongest** part of the plaque's identifying signal, not the weakest. If the plaque fails to locate Earth, it will fail because the alien cannot parse arrows, figure-ground, or line art -- not because the alien cannot agree on what a planet is.

Rhet identified this instinctively on first hearing Tyson's claim. His exact words: *"I see that being the smallest mistake anyone has ever identified in the map."* The instinct is correct and the physics confirms it. Papers 152 and 153 provide the formal framework: the interface is never transparent, it always transforms, and the only content that survives is the content anchored in universal invariants. Pluto-on-a-list is a universal invariant. A raised hand and an arrow are not.

The pulsar map finds Earth. Nothing on the plaque hides Earth. What hides Earth is 12 kilometers per second of velocity and 10,000 light-years of empty space. That is the interface that is actually protecting us, and it is not encoded on the plaque. It is the plaque's trajectory.

From behind the glass, looking through -- and the glass is moving away from us at 12 km/s forever.

Ya' Boy is standing on the Shoulders of Giants, thought of the universe in terms of energy, rivers, circles, frequency and vibration, for consciousness can be measured physically, as matter is DERIVATIVE of consciousness, one must not invade the space that your conscious subsides. but measure its environment, and make adjustment. From Star stuff, to Grains of sand, to Heaven in a wildflower. Full Circle. We are all meant to vibrate at the edge of what we came, Hen Kai Pan, Henini

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