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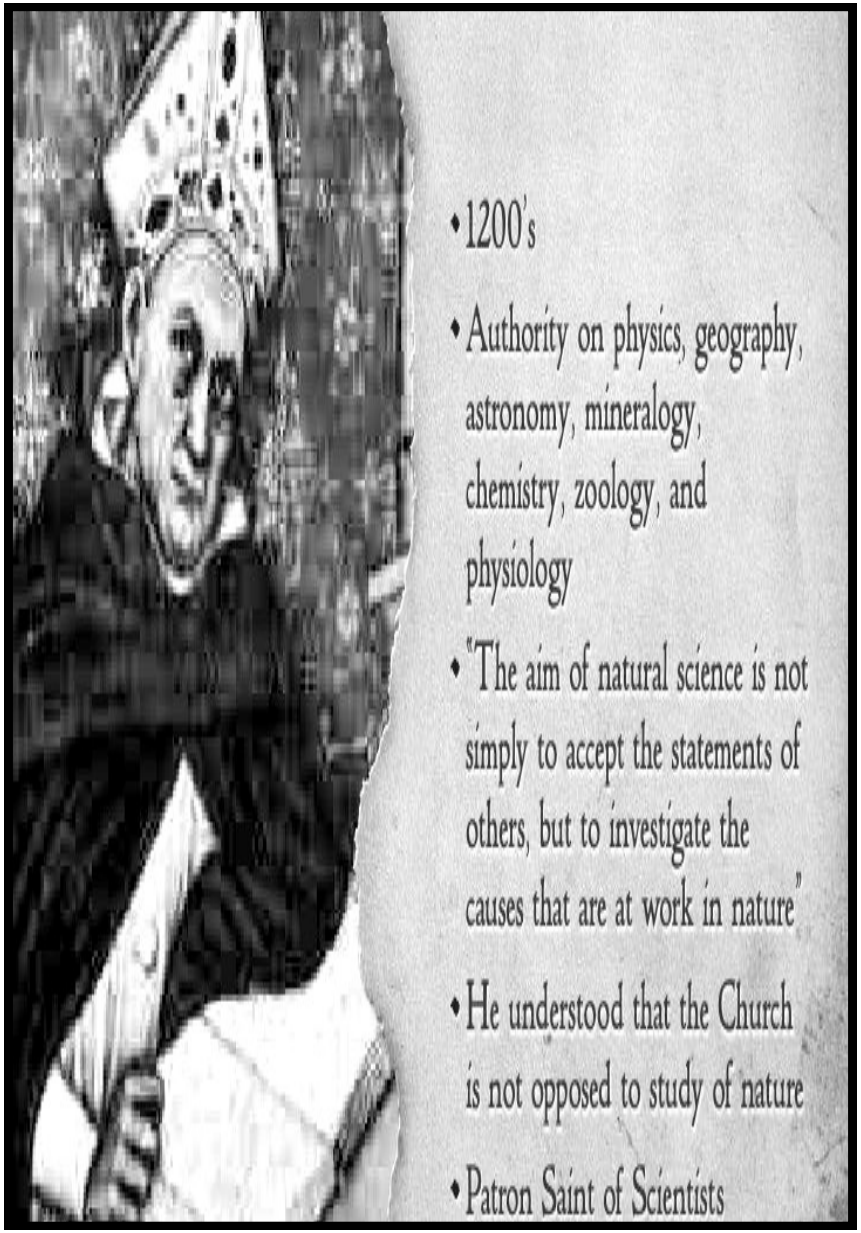
Catholic Physics - Reflections of a Catholic Scientist - Part 3

The Theology of Water – Is Design Intelligent?



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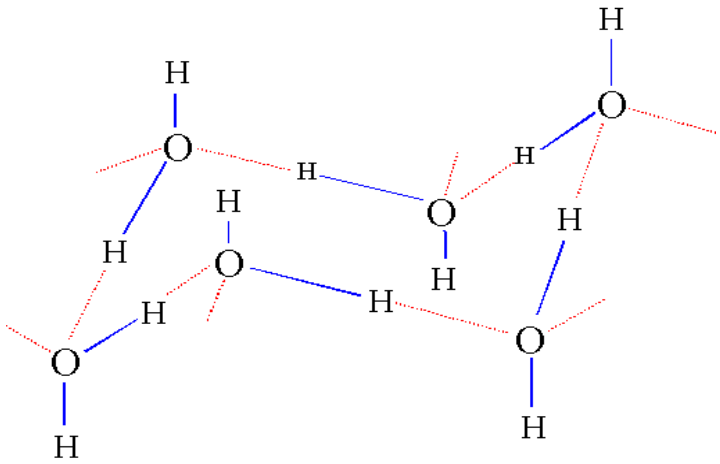
The Theology of Water – Is Design Intelligent?

“The water that I shall give him will become in him a fountain of living water, welling up into eternal life. This is a new kind of water, a living, leaping water, welling up for those who are worthy. But why did Christ call the grace of the Spirit water? Because all things are dependent on water; plants and animals have their origin in water.

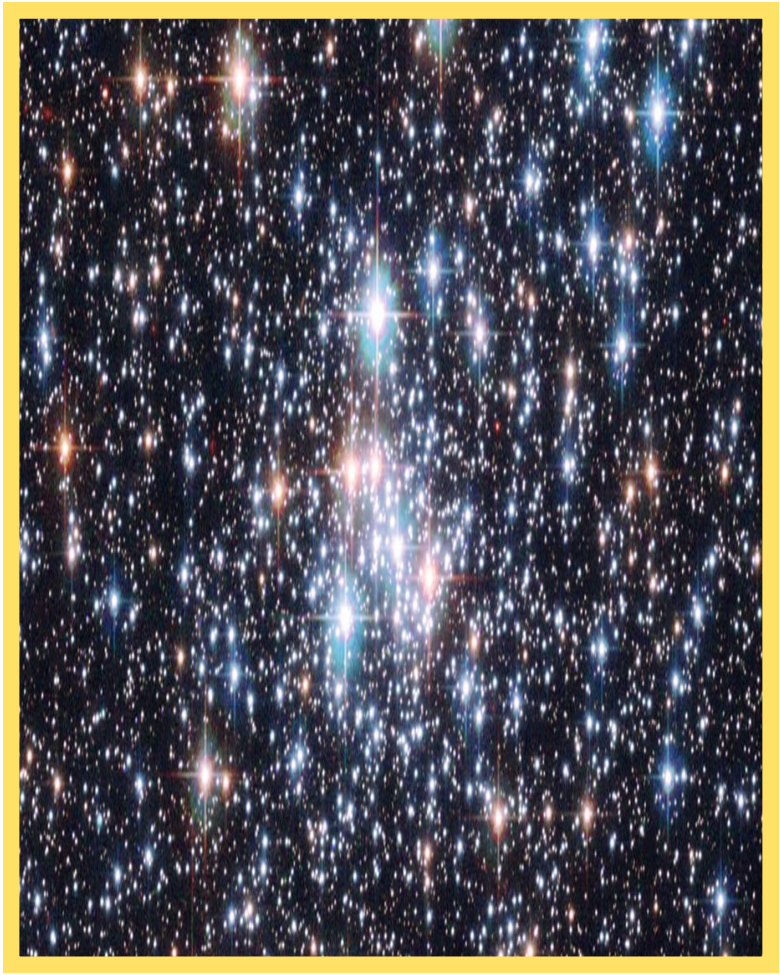
Water comes down from heaven as rain, and although it is always the same in itself, it produces many different effects, one in the palm tree, another in the vine, and so on throughout the whole of creation. It does not come down, now as one thing, now as another, but while remaining essentially the same, it adapts itself to the needs of every creature that receives it.”

Quoted in the “Office of Readings” (Monday, Week 7 of Easter), from a catechetical instruction by St. Cyril of Jerusalem.

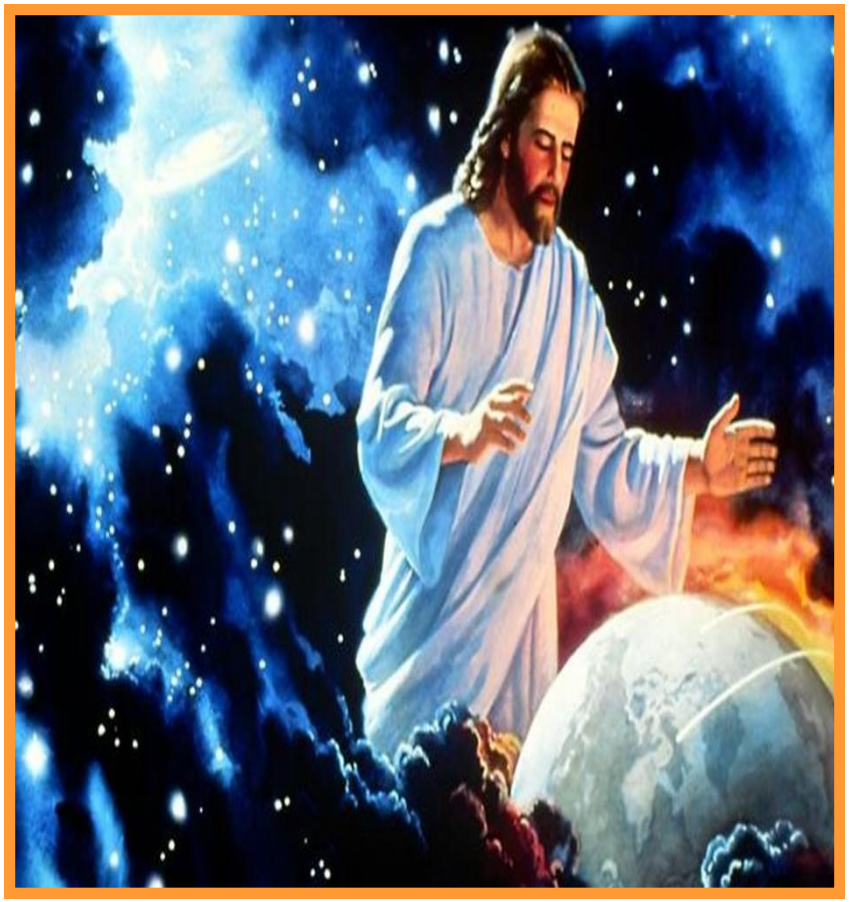


Atomic structure of ice; O's represent oxygen atoms; H's represent hydrogen atoms; blue lines represent chemical bonds; red lines, hydrogen bonds.

The title of this post, "The Theology of Water", is taken from a short story by Hilbert Schenck in a collection of science-fiction stories with a religious theme, "Perpetual Light", which I read several months ago.



the starter button. My God is a Trinity, a personal God, who intervenes from time to time in history, who sustains the laws of physics that make the universe-engine chug along, and who came to us in the person of His son, verified by historical revelation.



In this story, after fruitless searches in the rest of the solar system, some middle-aged astronaut scientists explore Titan, the largest moon of Saturn, to find life. Titan is unique amongst solar system satellites in having an atmosphere, albeit a very cold one.

The scientists don't find life in any form, but they do find a strange type of water: freezing and melting points much lower than "earth" water, but still with the unusual feature of solid water (ice) lighter than liquid at the freezing point, and with other differences in the thermodynamic properties. The different properties are in fact those that would be suitable for life on this cold world, if life existed. In testing the Titan water, the scientists turn it into earth-type water and realize that they are the life for which water is intended.

I dispute the essential scientific point of this story, that water at comparable temperatures and pressures would be different on Titan than on earth. The properties of ice– its relatively high melting point (compared to what one might expect doing a Periodic table comparison), it being lighter than liquid water–and the unusual thermodynamic properties of water can be traced ultimately to fundamental bonding properties, specifically to the properties of the hydrogen bond (see the illustration above), which in turn can be explained (in principle) by fundamental physics–quantum mechanics and electrostatics.

Nevertheless, in telling the story, Schenck makes this important point: the properties of water are tightly linked to the properties of the planet earth in order to provide an environment suitable for life (that is to say, carbon-based life as we know it). Here are those properties (and I quote from the story–all temperatures are in degrees Centigrade–0 degrees Centigrade is the normal freezing point of water):

1) liquid water has a maximum density at 4 degrees. If it didn't (if the maximum density was at the freezing temperature), the cold water would sink to the bottom of the ocean and earth's average surface temperature would be more than 20 degrees lower;

2) if the vapor pressure or the unusually high heat of vaporization of water is changed, either too much or not enough cloud would exist, which, in either case, would be a meteorological disaster;

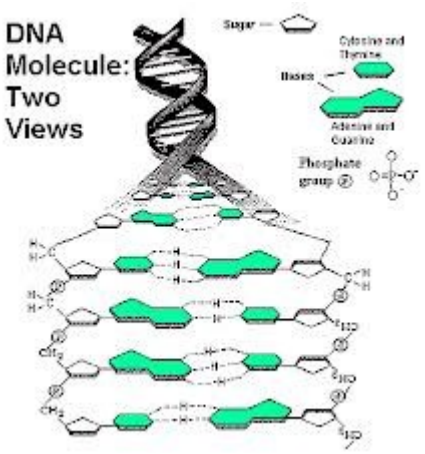
3) if the density of ice is greater than that of liquid water at the freezing point (for most substances the density of the solid is greater than that of the melt), the ice would sink to the bottom of the oceans and the oceans would be perpetually frozen at the bottom, leading to massive winds at the surface;

4) if the high specific heat of liquid water is reduced, the temperature stabilizing effect of the ocean is lowered, and more storms and lower average temperature results;

5) the properties of water are optimized for the tilt of the earth's axis (23.5 degrees from the vertical)–if it were 0 degrees tilt, the temperature stabilizing effect would be too large, with complete cloud cover and ice-caps down to 40 degrees latitude

6) in the story, the properties of water are set for a mean earth temperature that is optimum for metabolism at 98.6 degrees Fahrenheit (and guess to what temperature that corresponds?)

Our biochemistry crucially involves the chemistry of water and hydrogen bonding. The structure and reactions of proteins, enzymes, and DNA is critically dependent on hydrogen bonding, internally and to other biochemical molecules.



Biologists interested in alien life have considered biochemistries other than carbon-based/H2O. (See the Wikipedia article on hypothetical types of the hydrogen bonds between ammonia molecules are only half as strong as those between water molecules. Also, the temperature range for liquid ammonia is much lower than that for water, -78 to -33 degrees, so chemical reactions would proceed much more slowly, possibly too slowly for life-sustaining reactions.

So, the chemistry of hydrogen-bonding is one of those "finely-tuned" realities of nature that enable human life to exist. We recall the Anthropic Principle, used to explain the fine-tuning of physical constants and cosmological facts (among which are the age of the universe and the unlikely existence of a large moon for our planet) that enables the existence of intelligent, carbon-based life. I have not invoked the improbability of such fine-tuning, because probability, as a quantitative measure, is not properly applied to a single entity, and there is but one universe–we can know no other despite the speculations of metaphysical cosmologists.

How then do we justify the unlikelihood of such fine tuning, cosmological, physical and chemical? And when I use the term unlikelihood, I'm not referring to the improbability of picking one white ball out of a bag of a zillion black balls. Rather, I'm saying that we can think of all sorts of other universes, with different physical constants and laws, for which our type of life would not be possible. Indeed, it is hard to imagine how any of the operative laws/constants might be nudged just a little bit and still allow for our kind of life.

Such fine tuning for hydrogen-bonding physics and chemistry should not, I believe, be tossed as another ingredient into the Intelligent Design" (ID) stew. As I understand ID, its principal tenet is opposing the Darwinian model for evolution (common descent). Proponents of ID argue that gradual changes in form or biochemistry that might enhance survival (the cornerstone of the Darwinian survival-of-the-fittest program) are not sufficient to achieve the drastic differences in morphology and the "irreducible complexity" of various biochemical schemes.

To my mind this is a "God of the gaps" type argument–to attribute that which we don't understand to specific divine intervention. Moreover, a God who frames fundamental physics so that variety and complexity grows "naturally" from a unified beginning is much more to be admired and worshiped than a God who assembles, Leggo-like, all the objects of a Young Earth (including evidence for a 4.5 billion year old earth and a 14 billion year old universe). Paul Davies puts it very well:

"…the hypothesis of an intelligent designer applied to the laws of nature is far superior than the designer …who violates the laws of nature from time to time by working miracles in evolutionary history. Design-by-laws is incomparably more intelligent than design-by-miracles.[emphasis added]" (The Cosmic Jackpot: Why our universe is just right for life." p.200)

"Design-by-laws" (in Davies' felicitous phrase) is just how the anthropic principle can be interpreted. Since a full discussion of the anthropic principle would require a much lengthier blog, I'll defer that. But I would like to end with one further comment. This is a blog entitled "Reflections of a Catholic Scientist". And, as a Catholic scientist, my God is much more than a creator, a demiurge who designed the universe engine and pressed