Space Dimensions

1. Space Types

Newtonian space and time are separate, unchanging, passive, and absolute backgrounds for matter and motions.

Leibnizian space and time are object and event relations.

Machian space and time are relative to matter and energy amounts and relative positions.

Einsteinian space and time interrelate, change, are active, and have relative backgrounds for matter and motions.

Quantum-mechanical space and time are discrete, and entangled objects stay in direct contact over any space and time amount.

2. Space-Time

Time and space dimensions interact to make one unified space-time. Time dimension relates to space dimensions by light speed: space-dimension length divided by light speed is time, and time-dimension time times light speed is length. Only light speed matches experiment and makes special relativity true. All objects move through space-time at light speed. Space-time has no time flow or direction, so space-time represents all previous and future times in the same way as spatial dimensions represent all points in all directions.

3. Properties of Dimensions

At scales above subatomic distances, space dimensions are continuous and homogeneous.

Time dimension is isochronic. Physical processes are the same forward and backward in time. Motions have time symmetry, which is equivalent to the law of energy conservation.

Space dimensions are isotropic. Physical processes are the same in any space direction and dimension, so directions are equivalent. Motions have spatial symmetry, which is equivalent to the law of momentum conservation. Only infinite universes can be isotropic, so finite universes cannot be isotropic.

Physical processes are the same right-handed or left-handed, so rotation directions are equivalent. Motions have rotational symmetry, which is equivalent to the law of angular-momentum conservation [Feynman, 1965].

3.1. Time

Change shows time. Time orders changes.

Time flows forward, not backward. Time flows the same everywhere. Time changes are never symmetric.

However, in space-time, just as all space exists everywhere, all time exists always and everywhere. Space-time does not flow.

3.2. Curvature

Space-time dimensions can be straight or curved.

3.3. Quantum Effects

At quantum-mechanical sizes, space and time dimensions can superimpose and interchange, so dimensions are neither space nor time.

3.4. Lattice

Perhaps, space is a lattice, with particles at nodes. Lattices can have different spatial frequencies and wavelengths.

4. Why Space Has Three Dimensions

Universe has three long spatial real-number dimensions (and one long time real-number dimension).

4.1. Forces and Energies

If universe has no time dimension and any number of space dimensions, or any number of time dimensions and no space dimension, motion, energy, momentum, and space-time do not exist.

If universe has one or more time dimensions and more than three spatial dimensions, gravity and electromagnetism strengths decrease more quickly with distance, so star and planet orbits and electron orbits, respectively, are too lightly bound and are unstable. With one or more time dimensions and fewer than three spatial dimensions, gravity and electromagnetism strengths decrease less quickly with distance, so stars and planets and electrons quickly move to center, and stars, planets, and electrons do not exist.

If universe has more than one time dimension and one space dimension, fields are unstable. If universe has more than one time dimension and more than one space dimension, physical events are unpredictable.

4.2. Electromagnetism

Electron current, magnetic field, and atom radius define three space dimensions, so electromagnetism requires at least three spatial dimensions. Space cannot have more than three spatial dimensions, because then electron current, magnetic field, and atom radius have two or more independent relations for electric and magnetic fields.

4.3. Entropy

Perhaps, because fewer dimensions make lower entropy, universe has four-dimensional space-time because that has lowest entropy consistent with maximum energy. Perhaps, universe has optimum number, length, and geometry of space-time dimensions to allow highest number of states, most stability, and most symmetries.

4.4. Quantum Loop Theory

Quantum-loop intersection topology, knots, and kinks define space dimensions, so quantum loops define three infinite spatial dimensions.

5.0. Can Dimensions Change?

Perhaps, dimension number, length, and geometry were or are in flux. Dimension number varies from zero to infinite. Dimension lengths vary from zero to infinite length. Dimension geometries vary from linear to curved to curled up. Perhaps, dimensions evolve by physical processes to stable numbers, lengths, and geometries. Perhaps, energy and matter distributions dynamically determine dimension number, length, and geometry. Perhaps, multiverses or different universe regions have different dimensions. Perhaps, beginning universe had zero dimensions.

5.1. Hidden Dimensions

Perhaps, space has hidden dimensions, so separate universes are at the same space point.

Perhaps, to allow supersymmetry and supergravity, space-time has extra Grassmann dimensions.

5.2. Short Dimensions

Perhaps, space has curled-up real-number dimensions.

5.3. Imaginary-Number Dimensions

Perhaps, space has infinite and/or curled-up imaginary-number dimensions, and particles are adjacent in that dimension while apart in real dimensions. Time imaginary-number dimension has no direction. Imaginary-number time can be decreasing or increasing, just like spatial dimensions.

5.4. String Theory

String and brane theories require three infinite spatial dimensions and seven or eight curled-up spatial dimensions.

Bibliography

Feynman, Richard (1965) *The Character of Physical Law*. New York: Modern Library.
