Density is relative to speed and has no maximum

Introduction and relevance

The laws of physics in proper frames (at high speed for example) are limited in their applicability. By definition, all laws of physics are valid within a Noether frame. This is a wider reference frame within which energy and momentum conservation can be proven. For example, energy conservation requires the speed of light to be invariant to time in the *wider* reference frame, not just in the local reference frame.

Scientists apply the laws of physics in the Large Hadron Collider (LHC) at CERN where particles are being researched. Based on energy and momentum conservation, the LHC and its environment is a Noether frame with Noether observers. The key question is, to what extend can a (hypothetical) proper observer, travelling along with a proton within the LHC, apply the laws of physics?

It has enormous consequences to the density of neutron stars and black holes: the authors will show that density is depending on speed and that there is no maximum to the density. High temperature means a high average speed of mass-particles. Neutron stars and black holes have a very high temperature at its core, with relativistic speeds of mass-particles. Today, science assumes that the maximum density amounts to about 10 to the power 18, about the density of a proton at rest.

Proper observer at speed

The speed of a proton in the LHC is very close to the speed of light: v = 299,792,455 [$m.s^{-1}$]. The Lorentz boost-factor "γ" of such a proton in the LHC equals:

$\gamma = 1 / (1 - v^2 / c^2)^{½} = 7{,}500$ [ ] boost-factor of proton in LHC

The proper *basic units* of the S-MKC system are 7,500 times as large, see our book I "Repairing Special Relativity". The *space coordinates* within the proper frame are thus 7,500 times as small (length-, width-, and height-contraction), due to the *principle of uniform measurement*. This means that the volume as measured by the proper observer is the boost-factor to the power three smaller.

In contrast with the smaller volume, the proper mass of the proton of 1.67×10^{-27} [kg_0] remains the same at any speed, according to the *invariance postulate*, see appendix D of book I. The following table summarizes the effects of speed on a proper and Noether observer at rest and at speed:

	proper at rest	Noether at rest	Proper at speed	Noether at speed
mass proton	1.67×10^{-27}	1.67×10^{-27}	1.67×10^{-27}	1.25×10^{-26}
volume proton	2.81×10^{-45}	2.81×10^{-45}	6.66×10^{-57}	2.81×10^{-45}
density proton	5.96×10^{17}	5.96×10^{17}	2.51×10^{29}	4.47×10^{18}

The units of the proper values are in [kg_0], [m_0^3], and [$kg_0.m_0^{-3}$]. Notice that both the proper and the Noether observer measure a higher density, although the uniform measurement is the same. The proper density at speed of 2.51×10^{29} [$kg_0.m_0^{-3}$] far exceeds the (assumed) density of neutron stars of 1.0×10^{18} [$kg.m^{-3}$]. The key question is thus, is proper density an invariant property of

physics, like mass and lifetime? The mass and the lifetime of particles have been proven to be an invariant proper property of particles. From the table you can see that density depends on the observer.

There is no such thing as a maximum density, even the Noether observer measures an increased density in excess of the *assumed* 1.0 x 10^{18} [kg.m^{-3}] at speed. Any density can be obtained by changing the speed and thus the boost-factor. This means that the idea of one liter water having a mass of one kilogram is only valid at non-relativistic speeds at low temperatures.

The density of the proton is thus depending on the observer, although the uniform density (coordinate times unit) is measured the same by all observers. To the LHC (Noether) observer, because the mass increases with the boost-factor ($m = \gamma.m_0$), the density is the boost-factor higher than a proton at rest. To the proper observer, the density is the boost-factor to the power three higher than at rest, because of the reduced volume in coordinates.

To answer the question of the invariance of density: neither proper density nor Noether density can be invariant to speed (or gravitation) without being inconsistent with the invariance postulate, in which space contracts as measured by the proper observer and mass increases as measured by the Noether observer. This might put density in a very special category: invariant in its uniform format only (coordinate times unit)! This would force physicists to apply physics in natural coordinates only, when it comes to high-speed particles! Natural coordinates are coordinates without units, see the book III, “Repairing Robertson-Walker’s Solution” chapter 10 and 11.

There might be a maximum to natural density (density in natural coordinates), but how much?

Summary

There is no maximum to density in coordinates, neither in proper coordinates, nor in Noether coordinates. Physics is normally described in Noether coordinates, but do we need to go into natural coordinates when it comes to density? This remains an unanswered question.

Our books

In our books we resolve the problems of General Relativity solutions with the same methodology; there is no need for the introduction of “singularities” in black holes or “dark energy” in the universal model. You may freely download the first three chapters of our book “Repairing Special Relativity”, at www.loop-doctor.nl; We hope that you get as many “aha” experiences as we did.

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