

Submissions to Winter AAPT 2025 at Union Station in St. Louis this coming January.

## **Everyday relativity**

### **Spacetime effects here on earth: Moving beyond global time (9/25 words)**

We make the case here that we live in a very relativistic world, with for example: (a) car speedometers that register proper-velocity with no lightspeed upper limit, (b) inertial, centrifugal & gravitational forces linked to differential-aging, and of course (c) magnetism, powered by length-contraction, that makes electric motors & even light possible. If you use or experience any of these things, your world is being colored by an everyday link between space & time. Moreover use of “traveler-point variables”, like frame invariant proper time  $\tau$ , proper-acceleration  $\alpha$ , and synchrony-free proper-velocity  $w \equiv \delta x / \delta \tau = \gamma v$ , open up a way to quantify high-speed kinematics (including acceleration) and dynamics (including local “geometric forces”) in terms of physical units that naturally recognize the local distinction between space and time, and are especially easy to apply with one space & one time dimension. (139/205 words)

**Vivian's travel diary** with Dr. Chathuri Silva and Dr Phil Chrostoski

### **Vivan's travelogue: Tales told by an interstellar traveler**

Extraterrestrial materials in the laboratory can have amazing stories to tell. For example the story told by a micron-sized sphere extracted from the meteorite Murchison, and formed in the neighborhood of an AGB star like that which created the carbon nuclei inside you, may provide a way to tie together scientific detective work that ranges over processes in labs here on earth, through the history of our solar system, and the adventures of particles in the interstellar medium, to atom-scale events that took place during solidification in a carbon star's photosphere. In addition to tying atom-scale observations on earth with atom-scale processes in stars via the scientific method, classroom spinoffs from this story might include analysis of the particle size limit on radiation pressure ejection from star systems, and use of on-line transmission electron microscope simulators to do detective work on the size and arrangement of graphene sheets in a frozen carbon droplet.

## **Dimensionless units**

### **An "unhiding" table of dimensionless units, to simplify physics across disciplines**

In some fields, wavenumber is in radians per meter, in others it is in cycles per meter, but in both cases only "reciprocal distance" units are cited<sup>[6]</sup>. Planck's constant is in joule/Hz while  $\hbar$  is the same thing in joule seconds/radian. Angular momentum is most always in  $\text{kg m}^2/\text{s}$  per radian, rather than per cycle. Avogadro's number is now an integer number of molecules per mole, but no longer precisely the number of atomic mass units (or Daltons) in a gram. Boltzmann's constant  $k$  is in joules per kelvin per nat of correlation information. This makes temperature  $kT$  a measure of thermal energy needed per information unit of state uncertainty increase, and heat capacity  $Cv/k$  a multiplicity exponent e.g. in bits of uncertainty increase per two-fold increase in temperature. Thus, in some cases being explicit about dimensionless units can increase accessibility and provide insight into the assumptions behind rules of thumb, like the idea gas law, equipartition, and mass action.