

Gaussian and Planckian Distributions in Brain Processes underlying Decision-Making and Mind-Body Coordination. Sungchul Ji, Department of Pharmacology and Toxicology, Ernest Mario School of Pharmacy, Rutgers University, Piscataway, N.J. 08854.

During the past 6 years at Rutgers [1, 2], a mathematical equation called the Planckian distribution (PD) has been found that fit data measured from a wide range of natural and human sciences, including (i) atomic physics, (ii) polarized cosmological microwave background radiation, (iii) protein folding, (iv) single-molecule enzyme catalysis, (v) protein-length frequency distributions in living cells, (vi) whole-cell mRNA metabolism in yeast, (vii) whole-cell mRNA metabolism in human breast tissues, (viii) T-cell receptor variable region gene diversity, (ix) fMRI (functional magnetic resonance imaging) signals from a human brain before and after infusing the hallucinogen, psilocybin, (x) word-length frequency distributions in a speech delivered by Kerry in 2004, (xi) word-length frequency distributions in prose, private letters and comments, and (xii) decision-making processes in humans.

PD, *i.e.*, $y = (a/(Ax + B)^5)/(Exp(b/(Ax + B)) - 1)$, has been derived from the Planck radiation equation discovered in 1900 and consists of two components – (i) the power function related to the number of standing waves per volume per frequency, and (ii) the exponential function specifying the average energy per mode of the standing waves [3]. PD is also related to the Menzerath-Altmann law discovered in glottometrics in 1928-80 [4] and recently connected theoretically to statistical mechanics [5].

In all the cases examined so far, the rising phase of the PD function has been found to overlap with the associated Gaussian function, suggesting that the PD implicates thermally excited random processes. Thus there may exist a common mechanism underlying all the Planckian processes (defined as the physicochemical and biological processes that generate numerical data that fit PD), and one such mechanism was recently proposed [2], called the SID-TEM-TOF mechanism, the acronym standing for Signal-Induced De-excitation of Thermally Excited Metastable states leading TO Function. The universality of PD has been attributed to the universal role of standing waves (and hence to the principle of the wave-particle duality) as well as to the universality of thermal or Brownian motions as a prerequisite to free energy-driven selection leading to functions [2]. The SID-TEM-TOF mechanism includes the mechanism of enzyme catalysis based on the concept of the conformon (*i.e.*, chemical reaction-derived conformational wave packets in biopolymers postulated to drive all goal-directed molecular motions in the cell) [6]. The degree of the thermally excited, free energy-selected organization of matter in space and time can be quantified using what has been referred to as the *Planckian information*, I_p , *i.e.*, the binary logarithm of the ratio of the area under the curve (AUC) of the Planckian distribution over that of the associated Gaussian distribution, $I_p = \log_2(\int P(x)dx/\int G(x)dx)$, expressed in the unit of bits per selection.

At a more abstract and qualitative level, there may exist another way to accounting for the universality of PD that is complementary to the physicochemical mechanisms discussed above. This so-called the “RPM category theory of human experience”, shown in Figure 1, is based on the observation that all of the processes obeying PD can also be accounted for by it qualitatively. Since PD fits data from brain functions (decision-making, fMRI signals, word-length frequency distributions in speeches, sentence-length frequency distributions in texts), it may be anticipated that numerical data generated from belief processes will also fit PD quantitatively and the RPM category qualitatively.

