

Colloquium

Thursday, April 9th, 2026 at 4 p.m.
Physics & Astronomy Building (PAB) 1-434

**Victor
Yakovenko
(UMD)**



The Mathematics of Human Population Growth and CO2 Emissions

As a postdoc at Rutgers University, I attended a physics colloquium presented by Sergei Kapitza in the fall of 1992. His talk argued that human population growth is hyperbolic with a singularity in the year 2026. Actually, this claim was first published by Heinz von Foerster et al. in 1960 in *Science*. Using current empirical data from 10,000 BCE to 2023 CE, we re-examine this claim. We find that human population initially grew exponentially in time as $N(t) \sim \exp(t/T)$ with $T \sim 3000$ years. This growth then gradually evolved to be super-exponential with a form similar to the Bose function in statistical physics. Population growth further accelerated around 1700, entering the hyperbolic regime $N(t) = C/(t_s - t)$ with the extrapolated singularity year $t_s = 2030$, which essentially confirms the claim by Kapitza and von Foerster et al. We attribute the onset of the hyperbolic regime to the transition to massive use of fossil fuels upon the Industrial Revolution, as evidenced by a linear relation that we find between world population and the increase in CO2 level from 1700 to 2000. But in the 21st century, the inverse population curve $1/N(t)$ deviates from a straight line and follows a pattern of "avoided crossing". As a result, the singularity transforms into a square-root Lorentzian peak at $t_s = 2030$ of the width $\tau = 32$ years. Our predicted year 2030 of the peak in human population is much earlier than in other demographic forecasts. We also find that the increase in the CO2 level since 1700 is well fitted by $\text{arccot}[(t_s - t)/\tau_F]$ with $\tau_F = 40$ years. It implies a Lorentzian peak in the annual emissions $d(\text{CO}_2)/dt$ at the same year $t_s = 2030$.

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Hosted by Seth Putterman