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The de Vries formula: a transcendental solution for Standing Travelling Circular waves

Abstract

Exploration of the de Vries formula[1] and its accuracy[2] (following removal of SI2019 assumptions) to latest experimental uncertainty[3] has led to a hypothesis that the formula is a transcendental solution of an infinite-summed (non-frictional) circular traveling **and standing** wave: a solution of harmonic sympathetic resonance.

The de Vries formula is a solution to a more general problem of looped harmonic resonance, where a circle is simply a special case of a loop. Where an open pipe (flute) has a harmonic frequency progression $\lambda/2$ and likewise a closed pipe (organ) $\lambda/4$, the de Vries Formula is instead a solution of sympathetic resonance in λ: a circle where the harmonic progression is of the travel *distance*.

In other words: the key is that the (frictionless) wave harmonics travel round the loop, and would normally phase-lock with themselves. However this produces a travelling wave. If however the wave is slightly longer it becomes a *standing* travelling wave as well. The interaction between each new harmonic with all previous harmonics thus results in a Triangular pattern (each contributing term in Γ) The de Vries Formula, matching this definition, and also being self-referencing, may be expressed as:

$$\alpha = \Gamma^2 (e^{-\frac{\pi}{4}})^2 \qquad \Gamma = \sum_{n=0}^{\infty} \frac{\alpha^n}{(2\pi)^{T_n}} \qquad T_n = \sum_{k=0}^{n} k \tag{1}$$

If each frequency is expressed in terms of $e^{-i\theta}$, then each term of the harmonic progressive sequence is a standard sum of frequencies (where, mathematically, multiplication is possible due to there being no complex component as this is a standing wave "cancellation" point, $\pi/2$):

$$e^{-i(\frac{\alpha}{2\pi})} \; e^{-i(\frac{\alpha}{(4\pi)})} \; e^{-i(\frac{\alpha}{(6\pi)})} \; ... \qquad \sum_{k=1}^{k} e^{-i(\frac{\alpha}{(2k\pi)})} \tag{2}$$

From the contribution of each harmonic element to the travelling-standing wave comes naturally the Triangular Number T_n, given that frequency multiples of 2π on a circle are all equivalent to 2π. The concept is better described by figure 2, Chiatti[5].

In summary: α is the solution that provides a standard (infinite progressive) standing wave superposition, but it is a travelling one (figure 4, Riggs[4]) with the wave phase-locked with itself to the length of the circumference. However when that same travelling wave continues its journey (infinitely, assuming a frictionless system) it is Γ that brings in the small corrective factor to make this travelling wave also a standing wave with all its infinitely-travelling recurrences of itself.

References

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