

The Yamagishi Spherical Compression Pressure Equation — 2nd Edition: the form $P = \frac{4}{3}\pi n v^2$ and its consistency with Papers 18 and 20 — [Paper 19]

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ABSTRACT

Substituting $m = 4\pi$ into the kinetic-theory pressure $P = \frac{1}{3}nmv^2$ gives

$$P = \frac{4}{3}\pi n v^2,$$

in which the coefficient $\frac{4}{3}\pi$ equals the volume of the 3D unit ball, $\text{Vol}(B^3)$. This connects to the kinetic energy of Paper 18 via $P = \frac{2}{3}nE_k$ with $E_k = 2\pi v^2$. All of these are elementary substitutions.

Correction carried over in the 2nd edition: The first edition combined this with the temperature of Paper 20 in its *first-edition* form $kT = \frac{4}{3}\pi v^3$, which required the **non-standard** equation of state $P = n kT/v$. The second edition of Paper 20 corrected the temperature to $kT = \frac{4}{3}\pi v^2$ (the first edition had misapplied equipartition by an extra factor of v). **This correction works in favour of the present paper:** with the corrected temperature, the **standard** ideal gas law

$$P = n kT = n \cdot \frac{4}{3}\pi v^2 = \frac{4}{3}\pi n v^2$$

holds directly, and the non-standard form is no longer needed.

Scope of this paper: This paper offers a **structural interpretation** of existing physical law. It does not claim the discovery of new physical laws or the proof of open problems. **Note on units:** Substitutions such as $m = 4\pi$ are a **choice of natural units**. G and $\hbar$ are dimensionful; their numerical values depend entirely on the unit system. Setting $G = 4\pi$ is legitimate in exactly the same sense as setting $G = 1$ (geometric units) or $G = 6.674 \times 10^{-11}$ (SI); **physics does not single out one of these as "correct."** What this paper exhibits is therefore **how the equations look in this unit system**, not a new fact about nature.

Introduction

In kinetic gas theory the pressure is $P = \frac{1}{3}nmv^2$, the $\frac{1}{3}$ arising from averaging over the three velocity components. Substituting $m = 4\pi$ combines $\frac{1}{3}$ and 4π into $\frac{4}{3}\pi = \text{Vol}(B^3)$.

The Yamagishi Spherical Compression Pressure Equation

Theorem (Yamagishi spherical compression pressure equation)

Under the Yamagishi patch $m = 4\pi$, the gas pressure takes the form

$$P = \frac{1}{3}nmv^2 = \frac{1}{3}n(4\pi)v^2 = \frac{4}{3}\pi nv^2$$

where $\frac{4}{3}\pi = \text{Vol}(B^3)$ is the volume of the 3D unit ball.

[2nd Edition] Note on the correction to Paper 20

The second edition of Paper 20 established that the first edition had misapplied the equipartition theorem, and corrected the temperature:

$$kT = \frac{4}{3}\pi v^3 \quad (\text{1st ed.}) \longrightarrow kT = \frac{4}{3}\pi v^2 \quad (\text{2nd ed.})$$

The first edition had multiplied the right-hand side of $\langle E_k \rangle = \frac{3}{2}k_B T$ by an extra factor of v .

This correction works in favour of the present paper. With the corrected temperature, the pressure obtained here is related to it by the **standard** ideal gas law:

$$P = n kT = n \cdot \frac{4}{3}\pi v^2 = \frac{4}{3}\pi nv^2$$

The non-standard form $P = nkT/v$ required by the first edition is no longer needed.

Connection to the kinetic energy of Paper 18

Theorem (Pressure–kinetic energy relation)

With the kinetic energy $E_k = 2\pi v^2$ of Paper 18:

$$P = \frac{4}{3}\pi n v^2 = \frac{2}{3}n \cdot (2\pi v^2) = \frac{2}{3}n E_k$$

This is the standard kinetic-theory relation $P = \frac{2}{3}n\langle E_k \rangle$, expressed with the patched kinetic energy.

Consistency with Paper 20 (temperature)

Substituting the corrected temperature $kT = \frac{4}{3}\pi v^2$ of Paper 20 into the **standard** equation of state $P = nkT$:

$$P = n kT = n \cdot \frac{4}{3}\pi v^2 = \frac{4}{3}\pi n v^2$$

which agrees **exactly** with the pressure obtained here.

[2nd edition note]: The first edition used the first-edition value $kT = \frac{4}{3}\pi v^3$ together with the non-standard form $P = nkT/v$. **Both have been withdrawn** (Section 2.1). With the correction in place, **the standard form $P = nkT$ holds directly** and no division by v is required.

Explicit Scope

- **What this paper establishes:** that substituting $m = 4\pi$ into the kinetic-theory pressure gives $P = \frac{4}{3}\pi n v^2$, and that this is algebraically consistent with Paper 18 ($E_k = 2\pi v^2$) and with the second edition of Paper 20 ($kT = \frac{4}{3}\pi v^2$). **All are elementary substitutions.**
- **What it does not establish:** (i) the origin of pressure (already given by kinetic theory); (ii) any dynamical role for $\frac{4}{3}\pi$ as a ball volume — it appears as a coefficient, but since $P \propto v^2$ **the expression as a whole is not a volume.**
- **On the consistency:** Papers 18, 19 and 20 agree with one another **because all three descend from the same substitution $m = 4\pi$** ; this is not independent confirmation. It is nevertheless worth recording that the first edition of Paper 20 (v^3) *broke* that consistency, so **the consistency check proved useful in locating the error.**

Conclusion

Substituting $m = 4\pi$ into the kinetic-theory pressure gives $P = \frac{4}{3}\pi n v^2$, in which $\frac{4}{3}\pi$ equals the volume of the 3D unit ball.

It relates to Paper 18 by $P = \frac{2}{3}nE_k$ and to the second edition of Paper 20 by the **standard** equation of state $P = nkT$.

This consistency was established by the correction to Paper 20. With the first-edition temperature $kT = \frac{4}{3}\pi v^3$, a non-standard $P = nkT/v$ was required; once the misapplication of equipartition was corrected, the standard form suffices. **We record this as a case in which a correction improved the coherence of the framework.**

References

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