

Notes on the page proof and publication of “Schallausbreitung in teilweise dissoziierten Gasen” by A. Einstein

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Recently, the page proof, with corrections, of Einstein’s publication on the “Propagation of Sound in Partly Dissociated Gases”, which appeared in 1920 in the Proceedings of the Berlin Academy of Sciences, was found in Leiden. The last two pages of the proof are crossed out and replaced by a sheet in Einstein’s handwriting. In these notes, I briefly address the following two questions:

- Concerning the page proof, what is the difference between the contents of the crossed-out pages and the new page?
- Concerning the publication, are Eqs. (18,21,22) correct?

I start with the second question. The publication on the website of the Institute Lorentz, scanned by the Max Planck Institute for the History of Science in Berlin as part of the ECHO initiative (European Cultural Heritage Online), contains hand-made changes to Eqs. (18,21,22). After doing the calculations myself, I found these changes to be correct. The corrections affect the final result of the publication, the speed of sound V .

Regarding to the first question, the crossed-out pages deal with V in the special case $RT \ll D$, while the new page contains a more general result for V , not restricted to the regime $RT \ll D$. In addition, the crossed-out pages contain errors. The speed of sound V_{new} on the new page and the speed of sound V_{old} on the crossed-out pages are given by

$$V_{\text{new}}^2 = \frac{p}{\rho} \left(1 + \frac{x_1^2 AB + R\bar{c}\omega^2}{x_1^2 B^2 + \bar{c}^2 \omega^2} \right), \quad V_{\text{old}}^2 = \frac{p}{\rho} \left(1 + \frac{R\bar{c}\omega^2}{\left(x_1 \eta_1 \frac{D^2}{RT^2}\right)^2 + \bar{c}\omega^2} \right), \quad (1)$$

with

$$\bar{c} = \frac{C}{n_1 + n_2}, \quad (2)$$

$$A = \left(\frac{2D}{T} - \bar{c} \right) \frac{n_1}{n_1 + n_2} + R \left(1 \pm \frac{4n_1}{n_2} \right), \quad (3)$$

$$B = \frac{D^2}{RT^2} \frac{n_1}{n_1 + n_2} + \bar{c} \left(1 \pm \frac{4n_1}{n_2} \right). \quad (4)$$

(The “ \pm ” refers to the error in Eq. (18): Einstein took the minus sign, it should be the plus sign.) Since both V_{old} and V_{new} originate from Eq. (18), we can compare V_{old} to V_{new} in the regime $RT \ll D$. The differences between the two are due to errors made in the calculation of V_{old} on the crossed-out pages:

- A factor $\eta_1 + \eta_2$ has not been properly divided out in the transition from Eq. (18a) to the next equation. This accounts for the difference between $x_1^2 B^2$ and $\left(x_1 \eta_1 \frac{D^2}{RT^2}\right)^2$ in denominators in V_{new} and V_{old} , respectively.
- $\bar{c}\omega^2$ in denominator in V_{old} should be $\bar{c}^2 \omega^2$. In the limit $\omega \rightarrow \infty$, V_{old} takes the wrong value.
- contribution $x_1^2 AB$ to numerator in V_{old} is ignored. This can be traced down to the transition from the intermediate equation between Eqs. (18a) and (19) to Eq. (19).

CONCLUSIONS:

- Concerning the page proof, what is the difference between the contents of the crossed-out pages and the new page? *Answer:*
 - The new page is a generalization of the crossed-out pages, which deal with a special regime.
 - The crossed-out pages contain errors.
- Concerning the publication, are Eqs. (18,21,22) correct? *Answer:*
 - Eqs. (18,21,22) are not correct. However, the scanned version with the hand-made changes is correct.