Kiang's formula predicts $\delta$ near 6 in H$_2$O whereas experiments give a $\delta$ around 4.2.

Kiang [1] recently proposed a formula relating the critical exponent $\delta$ defined by $P - P_c \sim (\rho - \rho_c)^{\delta}$ at $T = T_c$ to the compressibility factor $P_c/\rho_c k_B T_c$:

$$P_c/\rho_c k_B T_c = \xi(2 + 1/\delta)/\xi(1 + 1/\delta)$$  \hspace{1cm} (1)

where $P$ is the pressure, $\rho$ the particle density and $\xi$ the zeta-function. Eq. (1) follows from the droplet model for the liquid gas transition [2], if its formulas are applied also to droplets with few molecules only. ($\xi(x) = \sum q^{-x}$, where $q$ here counts the number of molecules within the liquid droplet.) A priori one should therefore not expect eq. (1) to be valid because the droplet model assumptions are made for large droplets only [2]. But this relation is in good agreement with experimental results for some simple liquids (CO$_2$, Xe, H$_2$, He) and is accurate [1] within 5 to 10% in the Van der Waals gas and for some lattices of the three-dimensional and the two-dimensional Ising model ($\delta = 3$, 5.2, and 15, respectively). If the critical behavior of quantities like $\rho - \rho_c$ or the curvature of the vapor pressure curve $d^2P_{\text{vap}}/dT^2$ is calculated from the droplet model then only large droplets enter the results; but in [3] also $(\rho - \rho_c)/\rho_c$ at $T_c$ and $(T_c^2/P_c) d^2P_{\text{vap}}/dT^2$ were calculated; thus the 'dangerous' zeta-functions enter also in some numerical factors, and these were found [3] to agree approximately with experiment [4]. Thus as long as no better theory exists the accuracy of eq. (1) can be checked by experiment only.

For H$_2$O it predicts [1] $\delta = 6.2$.

We present in fig. 1 H$_2$O isotherms at $T_c$ from [5] together with corresponding data [6, 7] for CO$_2$. They show $\delta = 4.2$ in H$_2$O in a region which is for CO$_2$ sufficiently near the critical point to fix $\delta$. According to [8] $\beta = 0.35$ for H$_2$O ($0.2 < \rho - \rho_c < 0.7$; $\rho_{\text{gas}} - \rho_{\text{liquid}} \sim (T_c - T)^{\beta}$ at the coexistence curve). Thus the critical isotherm in fig. 1 seems not to be measured in a transition region between a Van der Waals region ($\beta = \frac{1}{2}$, $\delta = 3$) and the critical region. In addition scaling laws predict [8] $\delta = 4.4$ in H$_2$O.

We conclude that $\delta$ in H$_2$O is nearer to the values usually observed in other phase transitions than to the higher values predicted by eq. (1) for polar gases. A possible explanation might be the long range dipole forces in H$_2$O. If the droplet model assumptions are extrapolated to very small droplets this approximation can be worse in H$_2$O than in other gases with a shorter molecular interaction range.

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References
4. M. Vicentini-Missoni et al., J. Res. N. B. S. 73A
5. S.L. Rivkin et al., Teploenergetika 9 (1962) 57,
   10 (1963) 66, 11 (1964) 72, 13 (1966) 59;
   J. Tanishita et al., 7th Intern. Conf. on Properties
   of steam, Tokyo, 1968.
   160, 358;
8. J.M.H. Levelt Sengers, 7th Intern. Conf. on Prop-
   erties of steam. Tokyo. 1968.

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