Recently extended thermodynamics (ET) for rarefied polyatomic gases and also for dense gases is proposed [1]. The aim of the present talk is to show the validity of this new theory through studying linear waves in rarefied polyatomic gases [4]. The dispersion relation is derived by this theory, and compared with experimental data [2, 3] and with the one derived by the Navier-Stokes-Fourier theory for hydrogen, deuterium and hydrogen deuteride gases. In particular we consider the dispersion relation in the temperature range where rotational and vibrational modes of molecules are excited.

We will report the following results:

- The prediction by the ET theory is consistent with the experimental data even in the high frequency range where the Navier-Stokes-Fourier theory is no more valid.
- The bulk viscosity and the relaxation times are evaluated. In particular, the temperature dependence of these values are estimated.

Moreover we will discuss the limit of ET for rarefied polyatomic gases to the one for rarefied monatomic gases [5], and prove the convergence of these two theories in the limit [6].

![Figure 1: The dependence of the dimensionless phase velocity \( \nu_{ph}/c_0 \) (left) and the dimensionless attenuation factor \( c_0\tau_S\alpha \) (right) on the reduced frequency \( \Omega \) for hydrogen at room temperature. Here \( c_0 \) and \( \tau_S \) denotes the sound velocity at the equilibrium state and the relaxation time, respectively. The solid and dashed curves denote the predictions by the ET and NSF theories, respectively. The squares, triangles and circles denote the experimental data [2, 3].](image.png)