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Spontaneous acoustic emission in a non ideal gas in the presence of a piston

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An analytic model to study the perturbation evolution in the space between a corrugated shock and the piston surface is presented. The exact Laplace transform of the pressure perturbations is derived for an arbitrary equation of state and its limits of validity are discussed. The conditions for stable oscillation patterns are obtained by looking at the poles of the Laplace transform. The D'yakov-Kontorovich (DK) criterion for the spontaneous acoustic emission of a corrugated shock wave is generalized. It is seen that besides the standard DK mode of oscillation, the shock surface can exhibit an additional set of discrete frequencies. The additional eigenmodes are excited when the shock is launched at $t = 0+$, due to the piston that reflects normal waves toward the shock. The first eigenmode (the DK mode) is always present, assuming that the Hugoniot curve has the correct slope in the V - p plane, whenever the shock shape is slightly modified. However, the additional frequencies only appear for sufficiently strong shocks. The total number of eigenmodes is limited in number by the equation of state of the material. Besides, for strong enough shocks, the piston pressure perturbations also show characteristic oscillations. The predictions of the model are verified for particular cases by studying a van der Waals gas, as in the works of J. W. Bates and D. C. Montgomery [Phys. Fluids **11**, 462 (1999), Phys. Rev. Lett. **84**, 1180 (2000)].