LIGO-T880013

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List of 3/1/89

Peter Saulsen:
Wind-induced Motion of Unprotected LIGO Vacuum Pipes

Rewiev report:

Peter Saulsen considered wind induced motion of a pipe pinched at the two ends. He uses Davenport and Novak's model to describe the fluctuating wind velocity as a function of the average wind velocity (eq. 1). The cross-correlation between the wind velocities at two different points is described by a coherence length (eq. 2). Three mechanisms are responsible for the random pressure fluctuations; the domination of each is conveniently determined by the Reynolds number. According to the final results the noise only becomes noticeable for wind speeds exceeding 8 Mph, when the Reynolds number exceeds 3×10^5.

The model given in this paper hinges on a modal decomposition of the stochastic wind force acting on the pipe. However, the details are not carried through. In particular, the statement on top of p.3: "To find the net force, I replace A by $A^{1/2}z$" , which is crucial to this decomposition, is not justified. If "the net force" is what is customarily called "the generalized force" in mechanics (for definition see for ex. Goldstein), I cannont derive this dependence. In fact, doing a classical modal analysis, I arrive at a different expression for the displacement noise of the pipe.

The numerical results given in fig. 4 and 5 are somewhat surprising, since they seem to indicate that the pipe motion is only comparable to measured seismic noise (see "A Study of the Long Baseline Gravitational Wave Antenna System" - MIT report 1983, The German Proposal 1987) which is of the order $x_{seismic}(f) \sim 10^{-5}\ cm/\sqrt{Hz} \times (1\ Hz/f)^2$. Note also that at frequencies higher then $\sim 10Hz$ the expected wall motion drops off steeper then the seismic motion. One does not usually hear seismic noise, but one would expect to hear the howling of a 10 Mph wind inside a 48" pipe. Unless this hunch in wrong, the results given in fig. 4 and 5 are an underestimate.

In conclusion, I would like to recommend that the arguments be made stronger by doing the proper modal decomposition of the wind stochastic force. It is clear that an experimental data point would be extremely usefull to calibrate the analysis, however, it is also clear that it is difficult to reach high Reynolds numbers with pipes much smaller then 48" in diameter.

Andrej Čadež

Pasadena, July 20,1988