# Problem 10: magnetic levitation

A rectangular superconducting plate of mass m has four identical circular holes, one near each corner, see figure. Each hole carries a certain magnetic flux (all the four fluxes are equal and of the same polarity). The plate is put on a horizontal surface which is also in a superconducting state. The magnetic push between the plate and the surface compensates the weight of the plate when the width of the air gap beneath the plate is d, which is much smaller than the distance between the plate's and holes' edges (denoted by Δ in figure); d is also much smaller than the radii of the holes.

When the plate levitates in such a way above the support, the frequency of its small vertical oscillations is ν_0. Next, a load of mass M is put on the plate, so that the load lays on the plate, and the plate levitates above the support. What is the new frequency ν of small vertical oscillations (when the load and plate together oscillate up and down)?
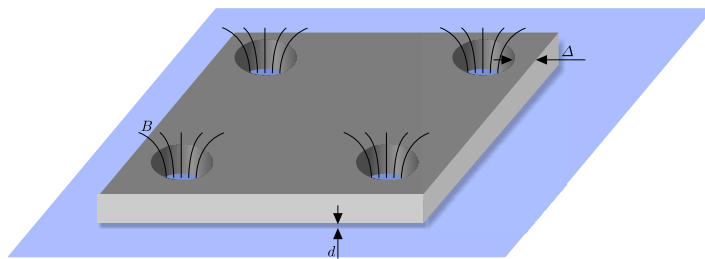
Hints after the first week. Due to the IPhO in Copenhagen, there are no hints this week (many contestants are attending IPhO and will not have internet access this week). Publication of the solutions of Problem 9 is delayed due to the same reason by one week.

Hints after two and half weeks. Study the solution of the Problem 1, Part C, question ii from the 43rd IPhO.

Hints after the third week. Find the repulsive force as a function of distance d: first calculate the magnetic field energy as a function of d, and further apply the virtual displacement method.