Repulsive Casimir force

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The Casimir force between two parallel thick plates, one perfectly electric, the other perfectly magnetic, has been calculated long ago by Boyer (1974). Its most characteristic property is that it is repulsive. The repulsiveness is counterintuitive and delicate, as it implies that the effective value of the squared electric field becomes negative. We analyze the problem by starting from the simple harmonic oscillator model introduced by us earlier (Høye and Brevik 2003, 2016). Extension of this model shows that the repulsive behavior can be understood on a microscopic basis, due to the duality between between canonical and mechanical momenta in the presence of an electromagnetic vector potential. This duality corresponds to TM and TE modes in electrodynamics. We analyze the generalized Boyer case where the permittivities and permeabilities of the plates are arbitrary. Based upon this statistical mechanical approach we find that whether a pair of plates attract or repel each other depends on their polarizabilities or permittivities/permeabilities.