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Bogoliubov theory of the ground state and low-energy excitations of a Bose-Einstein condensate of rigid-rotor molecules[1]

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Via Bogoliubov mean-field theory, we investigate the dipolar properties of the ground state and low-energy excitations of a Bose-Einstein condensate of rigid rotor molecules confined harmonically to two dimensions. An external polarizing field is applied that induces molecular dipole moments, and the molecules interact via dipole-dipole interactions. Under large electric fields, we reproduce the well-known density-wave instability that arises in a fully polarized BEC. Under small applied fields, a global instability arises that is associated with the development of an in-plane component of the molecular dipole moment. This arises at interaction strengths far below those necessary to see a previously-predicted spin-wave to arise. The BEC is unstable in this regime, and the complex dispersion relations are anisotropic, reflecting the spontaneous breaking of azimuthal symmetry. The physical character of these instabilities is clarified via spin and density static structure factors.

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