Dynamics of Josephson-phase coupled with spin waves

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Coupling of Josephson-phase and spin-waves is theoretically studied in a ferromagnetic Josephson junction, in which two superconductors (S's) are separated by a ferromagnet (F). Electromagnetic (EM) field inside the junction and the Josephson current coupled with spin-waves in F are calculated by combining Maxwell and Landau-Lifshitz-Gilbert equations. In the SFS junction, it is found that the current-voltage (I-V) characteristic shows *two* resonant peaks. Voltages at the resonant peaks are obtained as a function of the normal modes of EM field, which indicates a composite excitation of the EM field and spin-waves in the ferromagnetic Josephson junction. We examine a ferromagnetic Josephson junction, in which an insulator (I) is inserted in one of interfaces between S and F. In such an SIFS junction, *three* resonant peaks appear in the I-V curve, since the Josephson-phase couples to the EM field in the insulating layer.