Question 1 CP violation in oscillations

In the LHCb paper Phys. Rev. Lett. 114 (2015) 041601, a measurement is made of the semileptonic CP asymmetry

$$a^d_{\rm sl} \equiv \frac{\Gamma(\bar{B}^0 \to f) - \Gamma(B^0 \to \overline{f})}{\Gamma(\bar{B}^0 \to f) + \Gamma(B^0 \to \overline{f})} \,, \tag{1}$$

which is a measurement of CP violation in mixing. In the SM this is predicted to be very small in B decays. In this problem we will demonstrate the relationship between the theoretical parameters and what is actually measured. From the master equations (B14) and (B15) in the notes from Y. Nir, you get

$$a^d_{\rm sl} = \frac{1 - |q/p|^4}{1 + |q/p|^4} \,. \tag{2}$$

(a) Derive the expression for the decay rate to both f and $\overline{f}$ as given by Eq. (2) in the paper. You can assume that both the detector and the production assymetries are zero. Don't panic if you end up with the opposite sign, but make sure to specify your sign convention of the ingoing quantities.
(b) Comment on why this is a challenging experimental measurement.
(c) Starting from

$$a^d_{\rm sl} = {\rm Im}(\Gamma_{12}/M_{12}) \,, \tag{3}$$

which is valid in the approximation $|\Gamma_{12}| \ll |M_{12}|$, show that the approximate expression for $a^d_{\rm sl}$ in terms of $\Delta\Gamma$, Δm, and φ as given by Eq. (1) of the LHCb paper. Here φ is the relative phase between Γ_{12} and M_{12}, defined such that

$$\frac{\Gamma_{12}}{|\Gamma_{12}|} = \frac{M_{12}}{|M_{12}|} e^{i\varphi} \,. \tag{4}$$