

Supporting Online Information:

Asymmetric Phosphate Stretching mode: Effects of Mg^{2+}

Divalent magnesium (Mg^{2+}) was determined to interact with the headgroup phosphate moiety of dipalmitoylphosphatidylserine (DPPS) lipid through changes observed in the frequency of the asymmetric phosphate stretch. Binary DPPS/ perdeuterated dipalmitoylphosphatidylcholine (DPPC- d_{62}) lipid assemblies were prepared using 3:2 mole ratio of Mg^{2+} / total lipid. The spectra were acquired at 25°C. A fully hydrated DPPS phosphate headgroup exhibits a characteristic asymmetric phosphate stretching mode at 1221 cm^{-1} , as shown is figure S1a.¹ Upon binding inclusion of Mg^{2+} , the frequency of this vibrational mode in pure DPPS solution is observed to shift from 1221 to 1241 cm^{-1} (Fig S1b). This is in agreement with observations made using divalent calcium (Ca^{2+}), where the asymmetric phosphate stretching mode shifts to 1238 cm^{-1} .¹ The characteristic shift in the phosphate mode is also observed for the binary assemblies of 1:1 (Fig S2), 3:1 (Fig. S3), and 9:1 (Fig. S4) of DPPS to DPPC- d_{62} , respectively. The infrared spectra of the lipid assemblies obtained in the presence of Mg^{2+} continue to exhibit intensity in the unbound, hydrated, band at 1221 cm^{-1} . This is consistent with the PS/ Mg^{2+} binding expected from the reported binding constant.^{2,3} Interestingly, the phosphate moiety for a pure DPPC- d_{62} assembly, shown in figure S5, shows no change in the asymmetric stretching mode upon inclusion of Mg^{2+} . The DPPC- d_{62} assemblies exhibit a broad vibrational band centered at 1233 cm^{-1} , both with and without Mg^{2+} . These results strongly indicate that the Mg^{2+} binds selectively to the phosphate moieties of the DPPS lipids and does not directly interact with the DPPC- d_{62} lipid component.

References:

- (1) Dluhy, R.; Cameron, D. G.; Mantsch, H. H.; Mendelsohn, R. Fourier transform infrared spectroscopic studies of the effect of calcium ions on phosphatidylserine *Biochem.* **1983**, *22*, 6318.

(2) Nir, S.; Bentz, J. On the forces between phospholipid bilayers *J. Coll. Interf. Sci.* **1978**, *65*, 399.

(3) Duzgunes, N.; Nir, S.; Wilschut, J.; Bentz, J.; Newton, C.; Portis, A.; Papahadjopoulos, D. Calcium- and magnesium-induced fusion of mixed phosphatidylserine/phosphatidylcholine vesicles: Effect of ion binding *J. Membr. Biol.* **1981**, *59*, 115.

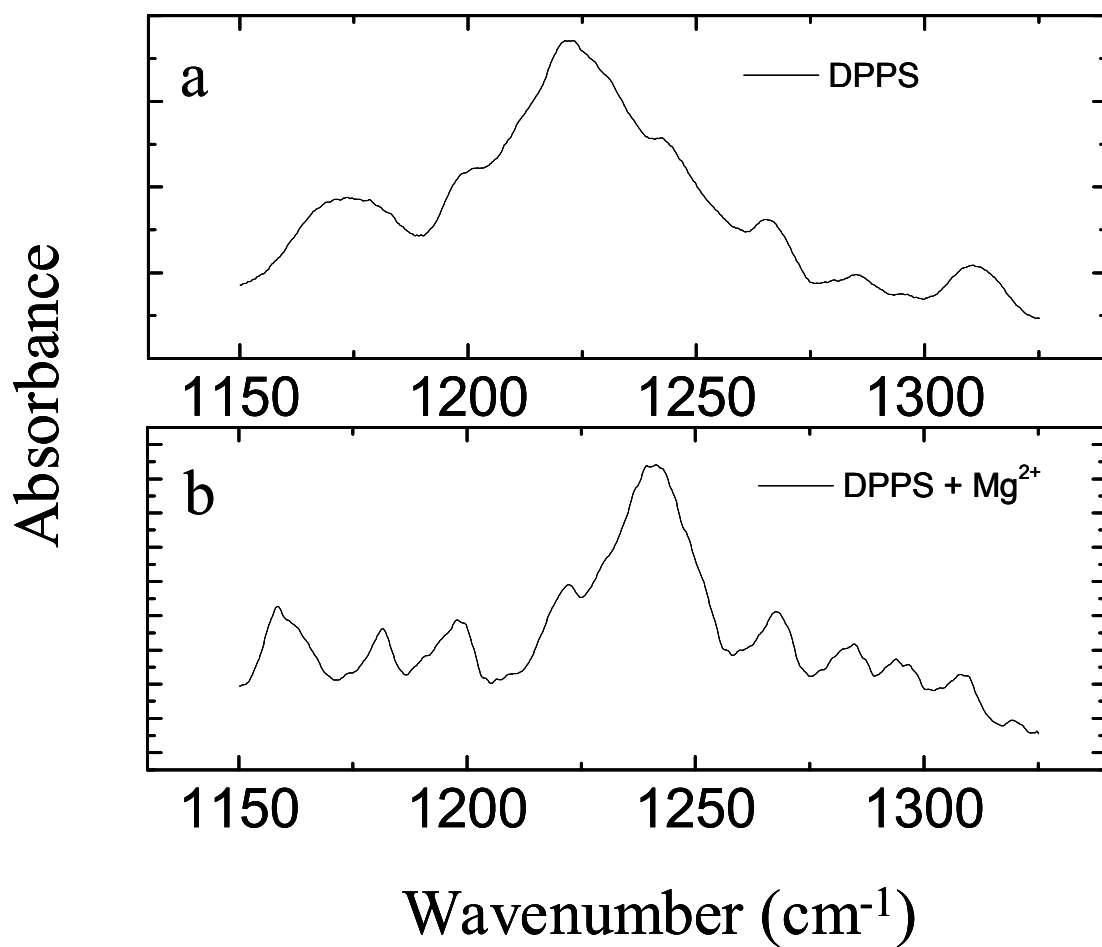


Figure S1. Infrared vibrational spectra obtained showing the asymmetric phosphate stretching mode for DPPS in the absence (a) and presence (b) of Mg²⁺.

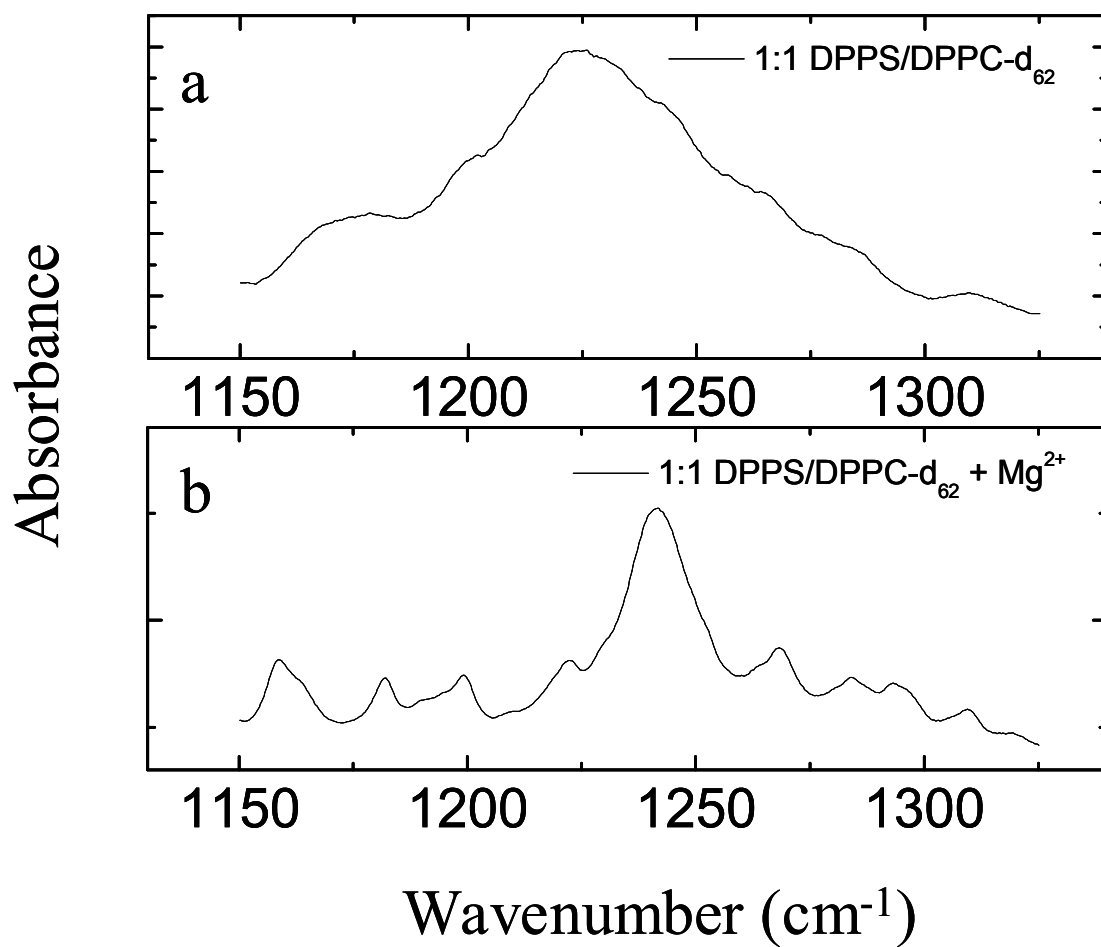


Figure S2. Infrared vibrational spectra obtained showing the asymmetric phosphate stretching mode for a 1:1 DPPS/DPPC-d₆₂ assembly in the absence (a) and presence (b) of Mg²⁺.

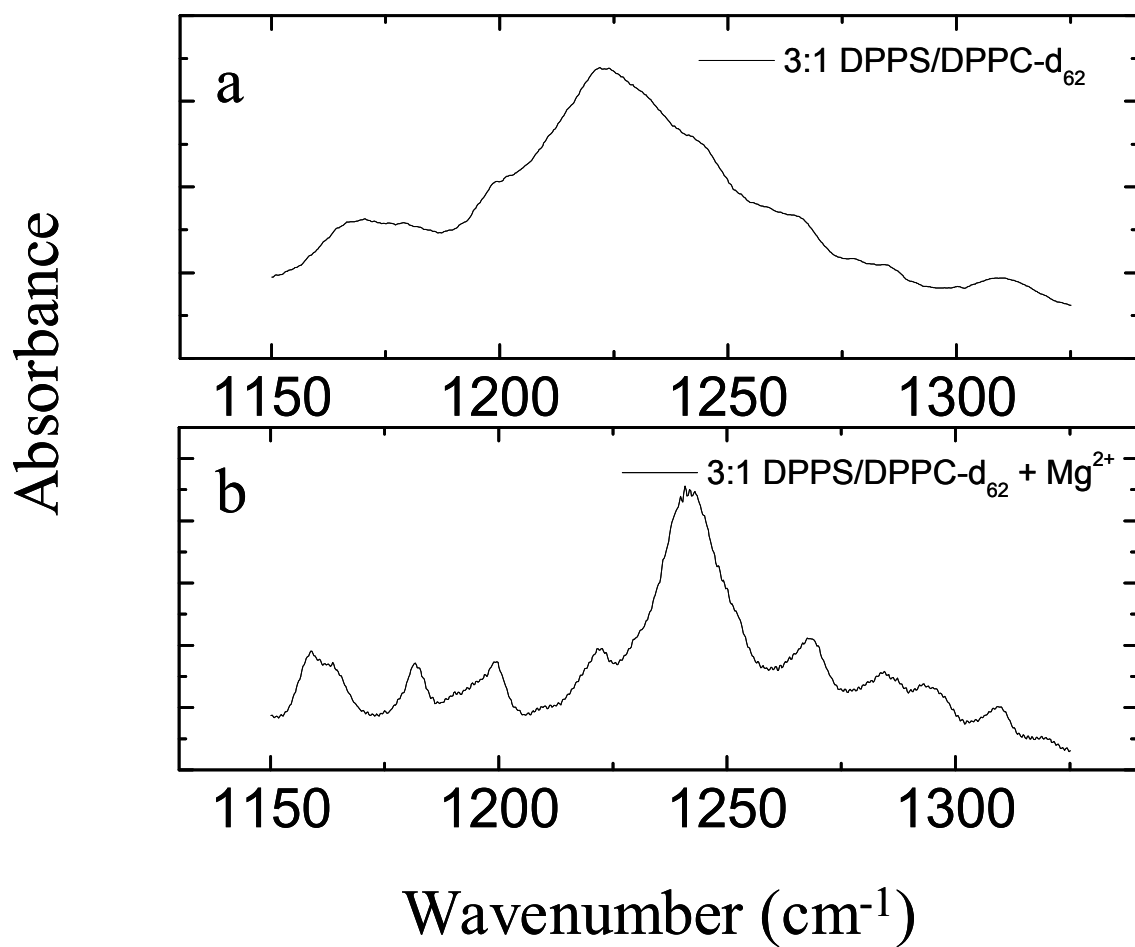


Figure S3. Infrared vibrational spectra obtained showing the asymmetric phosphate stretching mode for a 1:1 DPPS/DPPC-d₆₂ assembly in the absence (a) and presence (b) of Mg²⁺.

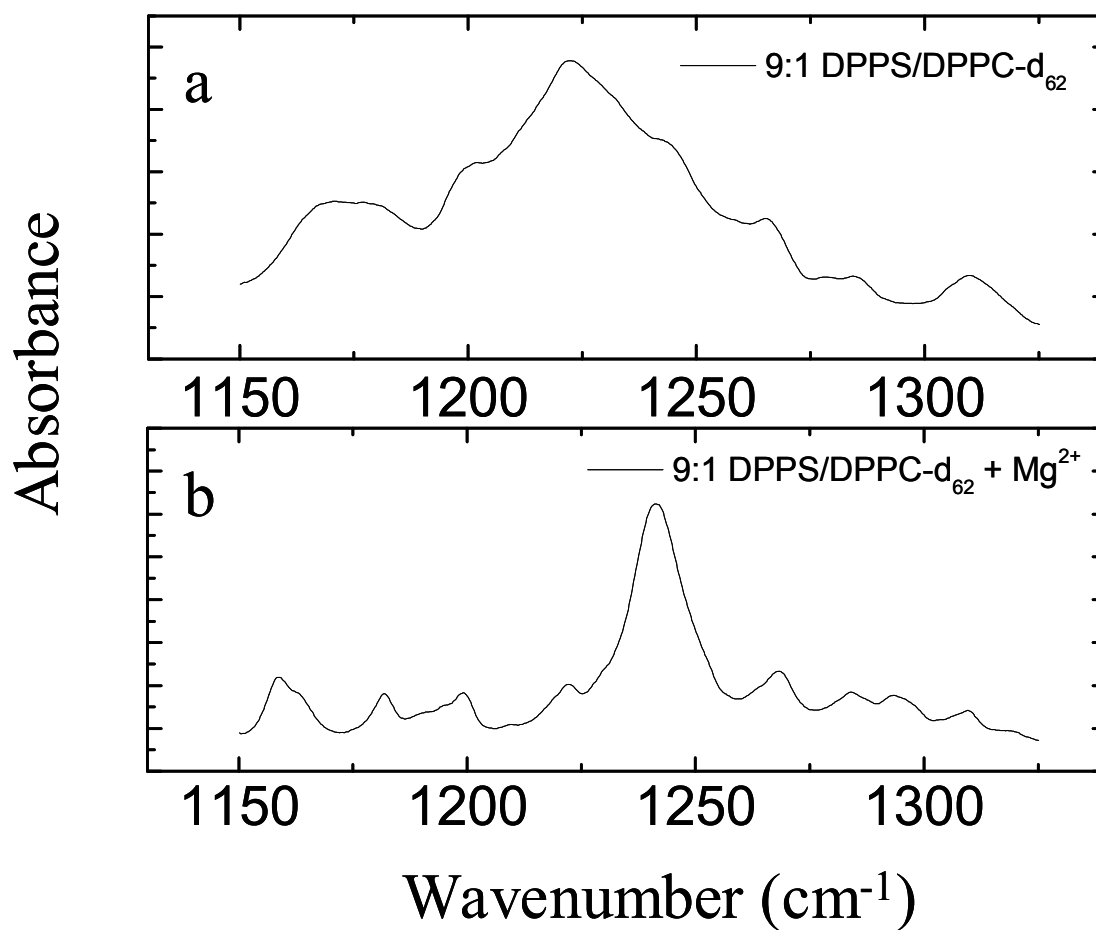


Figure S4. Infrared vibrational spectra obtained showing the asymmetric phosphate stretching mode for a 9:1 DPPS/DPPC-d₆₂ assembly in the absence (a) and presence (b) of Mg²⁺.

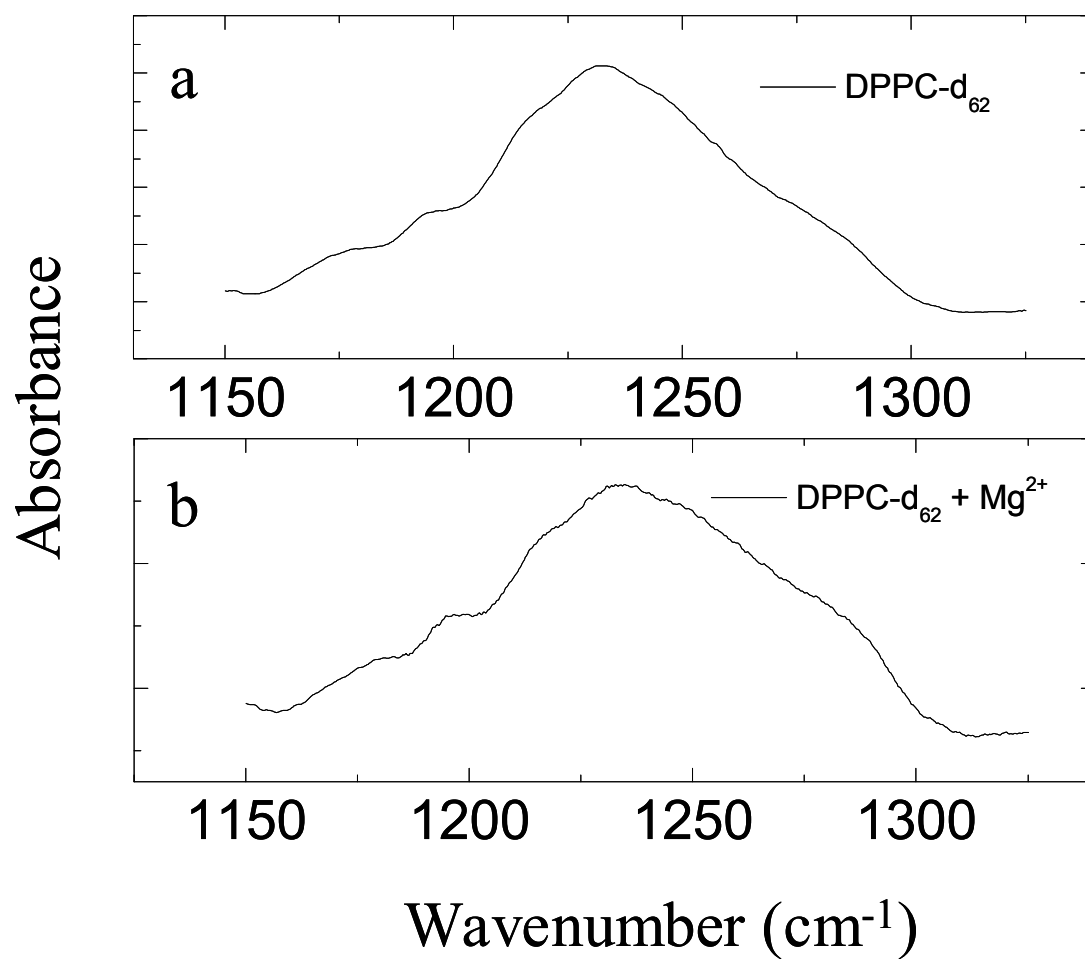


Figure S5. Infrared vibrational spectra obtained showing the asymmetric phosphate stretching mode for a DPPC-d₆₂ assembly in the absence (a) and presence (b) of Mg²⁺.