Charged Discs

Two thin metal discs of radius 5 cm each are suspended by electrically insulating threads such that the discs are parallel (see Fig. 1a) and close to each other (for example their distance could be 2 mm).

1. Calculate the force between the two discs if they are charged with small charges $+q$ and $-q$ respectively. As q is small, the displacement of the discs and the possibility of electric discharge can be neglected.

2. Now consider only one disc; calculate the surface charge distribution on a metal disc of radius R having total charge $+q$. (This charge distribution might be useful to answer the next question.)

After this, the two original discs are each charged $+q$. A third metal disc of radius $R^* > 5$ cm is carefully inserted between the two discs; the third disc is neutral and is suspended by an electrically insulating thread. The three discs are all parallel to each other and their centers lie along the same horizontal line (so that when viewed head-on the discs are concentric circles). The resulting set-up is shown in Fig. 1c.

3. Find the radius R^* of the third disc such that the net electrostatic force acting on each charged disc is zero. (The fringing effect is neglected in this problem).

Figure 1: Charged discs set-up