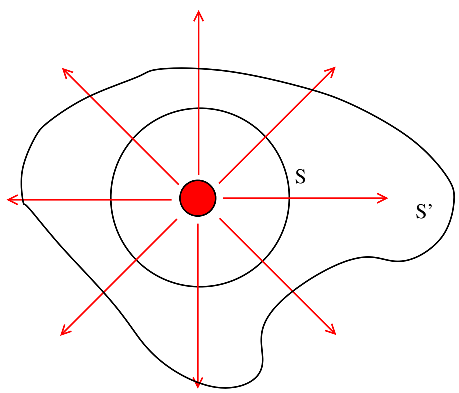

Figure 3: The flux through S and S' is the same.

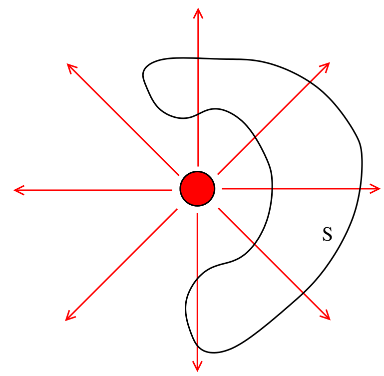

Figure 4: The flux through S vanishes.

Notice that it doesn't matter what shape the surface S takes. As long as it surrounds a total charge Q, the flux through the surface will always be Q/ϵ_0. This is shown, for example, in the left-hand figure above. A fancy way of saying this is that the integral of the flux doesn't depend on the geometry of the surface, but does depend on its topology since it must surround the charge Q. The choice of S is called the *Gaussian surface*; often there's a smart choice that makes a particular problem simple.

Only charges that lie inside V contribute to the flux. Any charges that lie outside will produce an electric field that penetrates through S at some point, giving negative flux, but leaves through the other side of S, depositing positive flux. The total contribution from these charges that lie outside of V is zero, as illustrated in the right-hand figure above.

For a general charge distribution, we'll need to use both Gauss' law (2.1) and the extra equation (2.2). However, for rather special charge distributions – typically those with lots of symmetry – it turns out to be sufficient to solve the integral form of Gauss' law (2.3) alone, with the symmetry ensuring that (2.2) is automatically satisfied. We start by describing these rather simple solutions. We'll then return to the general case in Section 2.2.

2.1.1 The Coulomb Force

We'll start by showing that Gauss' law (2.3) reproduces the more familiar Coulomb force law that we all know and love. To do this, take a spherically symmetric charge distribution, centered at the origin, contained within some radius R. This will be our model for a particle. We won't need to make any assumption about the nature of the distribution other than its symmetry and the fact that the total charge is Q.