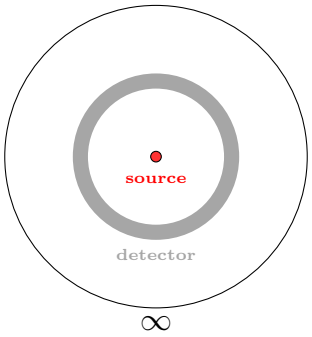

Figure 5.4. Geometry of the 2-group sphere problem

emission density is isotropic in a cell, then the score converges exactly to the scalar adjoint emission density. On the other hand, if the angular distribution of the flux and/or the adjoint flux is not isotropic, the score is biased, and the mesh should be refined in the angular direction to minimise the bias.

5.6.1 A homogeneous two-group infinite sphere

Let us start looking at a simple problem for which the adjoint flux can be calculated analytically easily. We define an infinite medium filled with a homogeneous material with an isotropic scattering cross section. The macroscopic cross sections for this material are given in two energy groups.

$$\Sigma_t^1 = 1\,\mathrm{cm}^{-1}, \Sigma_s^{1\to1} = 0.2\,\mathrm{cm}^{-1}, \Sigma_s^{1\to2} = 0.4\,\mathrm{cm}^{-1}, \Sigma_t^2 = 2\,\mathrm{cm}^{-1}, \Sigma_s^{2\to2} = 0.5\,\mathrm{cm}^{-1}$$

The sought response is the flux in the shell between $r = 5\,\mathrm{cm}$ and $r = 5.1\,\mathrm{cm}$. In this simple case, the reference adjoint solution can be written in closed form as an integral which can be numerically evaluated [Appendix A.2].

Figure 5.5 represents the reference solution integrated in 0.1 cm wide spherical shells from the source to the detector. The adjoint score is computed with AMS ($N = 1000$, $k = 10\%$) and is plotted for both energy groups. The score and the reference are perfectly coherent and within 2σ. The same computations were performed with the analog policy and lead to higher variance for the same simulation time.

5.6.2 A two dimensional, multi-group, heterogeneous problem

Now, let us validate the developments against a deterministic adjoint response. We take the same benchmark that was used to verify IDT [Appendix A.3]. In Figure 5.6a, the adjoint solution provided by IDT is plotted for the 5 energy groups of the problem. In order to obtain the adjoint score with TRIPOLI-4®, AMS was run with the importance map computed by INIPOND. The adjoint score was collected on the same mesh that was used with IDT. The simulation was stopped when the convergence was estimated to be sufficient. The resulting scores for the same energy groups as previously(see [Appendix A.3]) are plotted in Figure 5.6b. We observe that even after a long simulation, many regions of