of the atom in the FBG cavity can significantly affect the mean photon number as well as the photon statistics even though the cavity finesse is moderate, the cavity is long, and the probe field is weak.

The paper is organized as follows. In Sec. II we describe the model. In Sec. III we derive the density-matrix equations for the combined atom-field system. In Sec. IV we present the results of numerical calculations for the mean photon number, the second-order correlation function, and the atomic excited-state population. Our conclusions are given in Sec. V.

II. MODEL

We consider a two-level atom in the vicinity of a nanofiber with two FBG mirrors (see Fig. 1). The field in the guided modes of the nanofiber is reflected back and forth between the FBG mirrors. The nanofiber has a cylindrical silica core of radius a and of refractive index $n_1 = 1.45$ and an infinite vacuum clad of refractive index $n_2 = 1$. In view of the very low losses of silica in the wavelength range of interest, we neglect material absorption. We use the cylindrical coordinates (r, φ, z), with z being the axis of the fiber.

In the presence of the fiber, the electromagnetic field can be decomposed into guided and radiation modes [28]. In order to describe the field in a quantum mechanical formalism, we follow the continuum field quantization procedures presented in [29]. First, we temporally neglect the presence of the FBG mirrors. Regarding the guided modes, we assume that the single-mode condition [28] is satisfied for a finite bandwidth around the atomic transition frequency ω_0. We label each fundamental guided mode HE_{11} with a frequency ω in this bandwidth by an index $\mu = (\omega, f, l)$, where $f = +, -$ denotes the forward or backward propagation direction and $l = +, -$ denotes the counterclockwise or clockwise rotation of polarization. The quantum expression for the electric positive-frequency component $\mathbf{E}_{\mathrm{gyd}}^{(+)}$ of the field in the fiber guided modes is [30]

$$\mathbf{E}_{\mathrm{gyd}}^{(+)} = i \sum_{\mu} \sqrt{\frac{\hbar\omega\beta'}{4\pi\epsilon_0}}\, a_\mu \mathbf{e}^{(\mu)} e^{i(f\beta z + l\varphi) - i\omega t}. \tag{1}$$

Here $\mathbf{e}^{(\mu)} = \mathbf{e}^{(\mu)}(r, \varphi)$ is the profile function of the guided mode μ in the classical problem, a_μ is the corresponding photon annihilation operator, $\sum_\mu = \sum_{fl} \int_0^\infty d\omega$ is the summation over the guided modes, β is the longitudinal propagation constant, and β' is the derivative of β with respect to ω. The constant β is determined by the fiber eigenvalue equation [28].