1 Method

The Hamiltonian for the we are using has the following form

$$H = \sum_{i}^{N} \left(\frac{-\hbar^2}{2m} \nabla_i^2 + V_{ext}(\boldsymbol{r}_i) \right) + \sum_{i<j}^{N} V_{int}(\boldsymbol{r}_i, \boldsymbol{r}_j) \tag{1}$$

where the external potential given by the boson trap

$$V_{ext}(\boldsymbol{r}) = \begin{cases} \frac{1}{2} m \omega_{ho}^2 r^2 & \text{Spherical} \\ \frac{1}{2} m [\omega_{ho}^2 (x^2 + y^2) + \omega_z z^2] & \text{Elliptical} \end{cases} \tag{2}$$

and a repulsive potential due to bosons interaction given by

$$V_{int}(|\boldsymbol{r}_i - \boldsymbol{r}_j|) = \begin{cases} \text{inf} & |\boldsymbol{r}_i - \boldsymbol{r}_j| \leq a \\ 0 & |\boldsymbol{r}_i - \boldsymbol{r}_j| > a \end{cases} \tag{3}$$

As for the trial wavefunction for the ground state with N atoms

$$\Psi_T(\mathbf{R}) = \Psi_T(\mathbf{r}_1, \mathbf{r}_2, \ldots \mathbf{r}_N, \alpha, \beta) = \prod_i g(\alpha, \beta, \mathbf{r}_i) \prod_{i<j} f(a, |\mathbf{r}_i - \mathbf{r}_j|), \tag{4}$$

with α, β as variational parameters.