Lecture 5: Spin

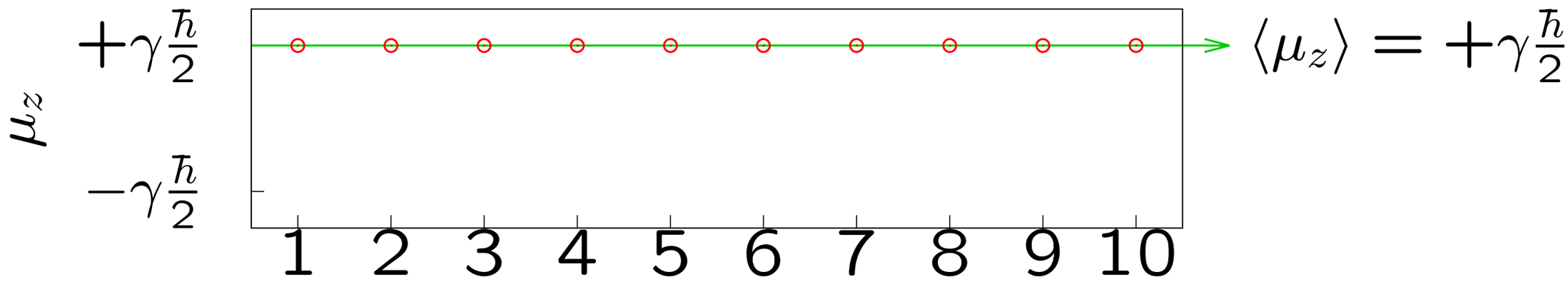
$$\left(\mathrm{i}\hbar\frac{\partial}{\partial t}\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&-1&0\\0&0&0&-1\end{pmatrix}+\mathrm{i}c\hbar\frac{\partial}{\partial z}\begin{pmatrix}0&0&1&0\\0&0&0&-1\\-1&0&0&0\\0&1&0&0\end{pmatrix}+\mathrm{i}c\hbar\frac{\partial}{\partial x}\begin{pmatrix}0&0&0&1\\0&0&1&0\\0&-1&0&0\\-1&0&0&0\end{pmatrix}+\mathrm{i}c\hbar\frac{\partial}{\partial y}\begin{pmatrix}0&0&0&-\mathrm{i}\\0&0&\mathrm{i}&0\\0&\mathrm{i}&0&0\\-\mathrm{i}&0&0&0\end{pmatrix}\right.$$
$$\left.-m_0c^2\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&0&1\end{pmatrix}\right)\begin{pmatrix}u_1\psi\\u_2\psi\\v_1\psi^*\\v_2\psi^*\end{pmatrix}=0$$

$$\hat{H} \approx \frac{1}{2m_0}\left(\left(\mathrm{i}\hbar\frac{\partial}{\partial x}+QA_x\right)^2+\left(\mathrm{i}\hbar\frac{\partial}{\partial y}+QA_y\right)^2+\left(\mathrm{i}\hbar\frac{\partial}{\partial z}+QA_z\right)^2+QV\right)\begin{pmatrix}1&0\\0&1\end{pmatrix}$$
$$-\frac{\hbar Q}{2m_0}\left(B_x\begin{pmatrix}0&1\\1&0\end{pmatrix}+B_y\begin{pmatrix}0&-\mathrm{i}\\\mathrm{i}&0\end{pmatrix}+B_z\begin{pmatrix}1&0\\0&-1\end{pmatrix}\right)$$

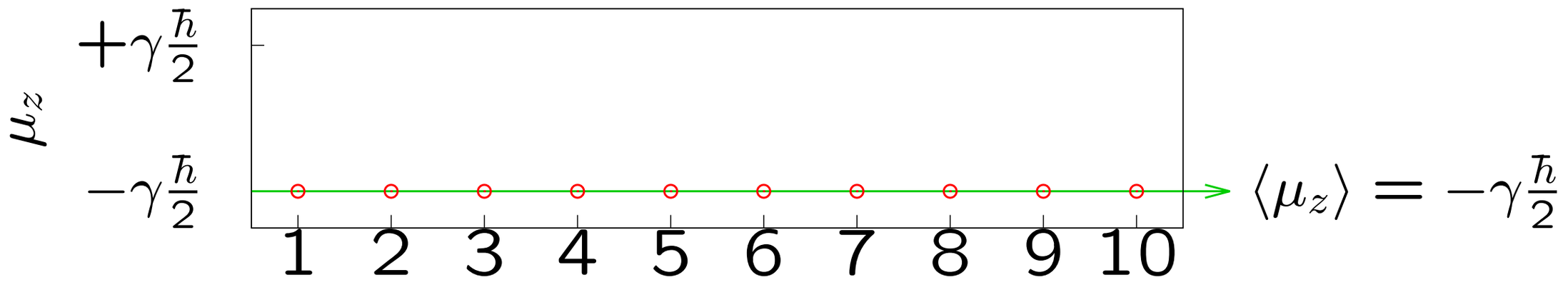
$$\gamma = 2\frac{Q}{2m}$$

$$\hat{I}_x=\frac{\hbar}{2}\begin{pmatrix}0&1\\1&0\end{pmatrix}\qquad \hat{I}_y=\frac{\hbar}{2}\begin{pmatrix}0&-\mathrm{i}\\\mathrm{i}&0\end{pmatrix}\qquad \hat{I}_z=\frac{\hbar}{2}\begin{pmatrix}1&0\\0&-1\end{pmatrix}\qquad \hat{I}^2=\frac{3\hbar^2}{4}\begin{pmatrix}1&0\\0&1\end{pmatrix}.$$

$|\Psi\rangle = |\alpha\rangle$

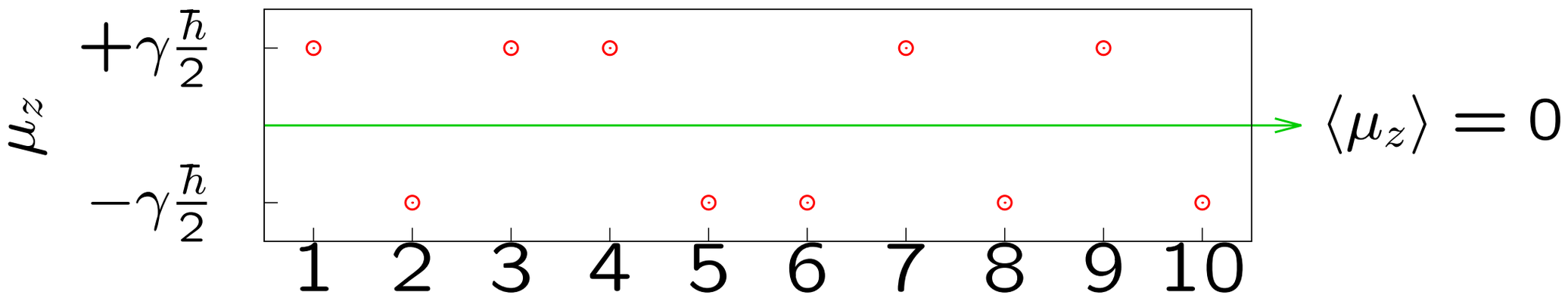


$|\Psi\rangle = |\beta\rangle$



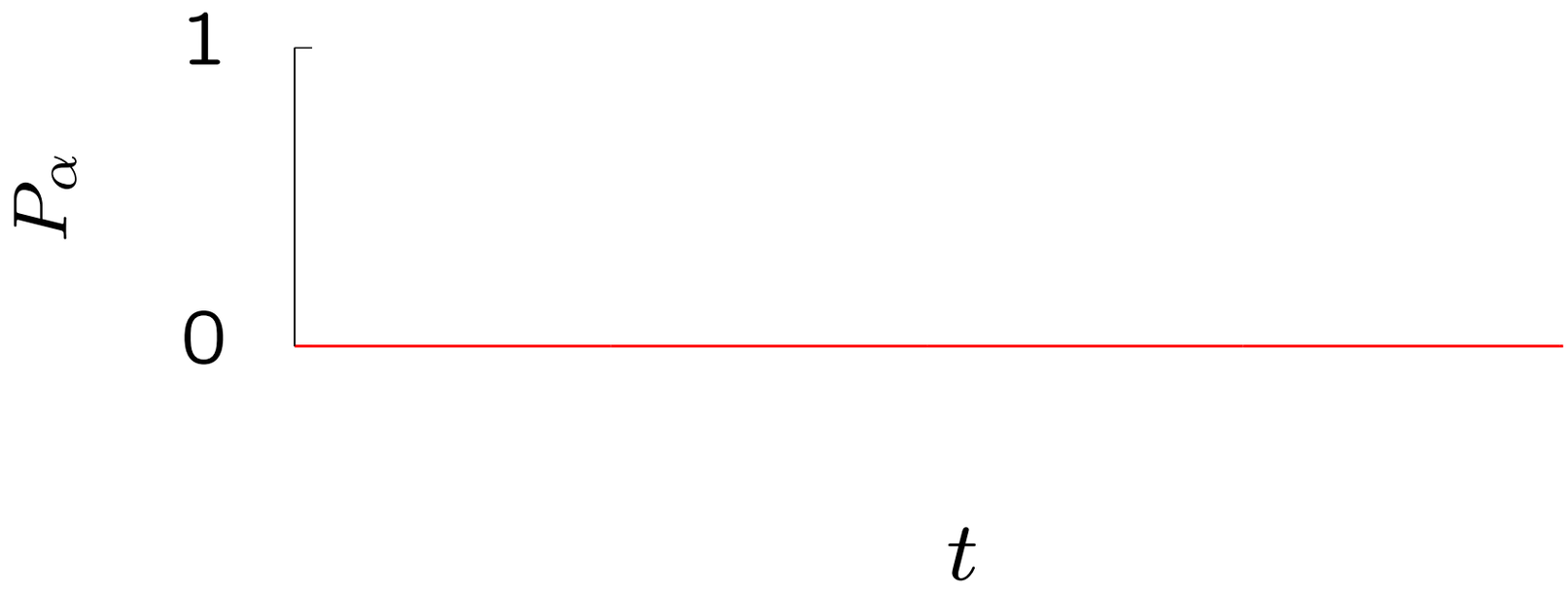
measurement no.

$$|\Psi\rangle = \tfrac{1}{\sqrt{2}}|\alpha\rangle + \tfrac{1}{\sqrt{2}}|\beta\rangle$$



$|\Psi\rangle(t=0) = |\alpha\rangle; \quad \hat{H} = -\gamma B_0 \hat{I}_z = \omega_0 \hat{I}_z$

$|\Psi\rangle(t=0) = |\beta\rangle; \quad \hat{H} = -\gamma B_0 \hat{I}_z = \omega_0 \hat{I}_z$



$$|\Psi\rangle(t=0)=|\alpha\rangle \quad \hat{H}=-\gamma B_1 \hat{I}_x=\omega_1 \hat{I}_x$$