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Hardy spaces associated with Schrödinger operators on the Heisenberg group

Let $L = -\Delta_{\mathbb{H}^n} + V$ be a Schrödinger operator on the Heisenberg group $\mathbb{H}^n$, where $\Delta_{\mathbb{H}^n}$ is the sub-Laplacian and the nonnegative potential V belongs to the reverse Hölder class $B_{\frac{Q}{2}}$ and Q is the homogeneous dimension of $\mathbb{H}^n$. The Riesz transforms associated with the Schrödinger operator L are bounded from $L^1(\mathbb{H}^n)$ to $L^{1,\infty}(\mathbb{H}^n)$. The L^1 integrability of the Riesz transforms associated with L characterizes a certain Hardy type space denoted by $H^1_L(\mathbb{H}^n)$ which is larger than the usual Hardy space $H^1(\mathbb{H}^n)$. We define $H^1_L(\mathbb{H}^n)$ in terms of the maximal function with respect to the semigroup $\{e^{-sL} : s > 0\}$, and give the atomic decomposition of $H^1_L(\mathbb{H}^n)$. As an application of the atomic decomposition theorem, we prove that $H^1_L(\mathbb{H}^n)$ can be characterized by the Riesz transforms associated with L.