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Weighted Local Orlicz-Hardy Spaces with Applications to Pseudo-differential Operators

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Let Φ be a concave function on $(0,\infty)$ of strictly lower type $p_{\Phi}\in(0,1]$ and $\omega\in A^{\mathop\mathrm{loc}}_{\infty}(\mathbb{R}^n)$. We introduce the weighted local Orlicz-Hardy space $h^{\Phi}_{\omega}(\mathbb{R}^n)$ via the local grand maximal function. Let $\rho(t)\equiv t^{-1}/\Phi^{-1}(t^{-1})$ for all $t\in(0,\infty)$. We also introduce the $\mathop\mathrm{BMO}$-type space $\mathop\mathrm{bmo}_{\rho,\,\omega}(\mathbb{R}^n)$ and establish the duality between $h^{\Phi}_{\omega}(\mathbb{R}^n)$ and $\mathop\mathrm{bmo}_{\rho,\,\omega}(\mathbb{R}^n)$. Several real-varaiable characterizations of $h^{\Phi}_{\omega}(\mathbb{R}^n)$ are presented. Using the atomic characterization, we prove the existence of finite atomic decompositions achieving the norm in some dense subspaces of $h^{\Phi}_{\omega}(\mathbb{R}^n)$. As applications, we show that the local Riesz transforms are bounded on $h^{\Phi}_{\omega}(\mathbb{R}^n)$, the local fractional integrals are bounded from $h^p_{\omega^p}(\mathbb{R}^n)$ to $L^q_{\omega^q}(\mathbb{R}^n)$ when $q>1$ and from $h^p_{\omega^p}(\mathbb{R}^n)$ to $h^q_{\omega^q}(\mathbb{R}^n)$ when $q\le 1$, and some pseudo-differential operators are also bounded on both $h^{\Phi}_{\omega}(\mathbb{R}^n)$. All results for any general Φ even when $\omega\equiv 1$ are new.

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