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Probing the NMSSM and MSSM with light neutralino dark matter through Higgs invisible measurements at the ILC

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We examine the region of the parameter space of the Next to Minimal Supersymmetric Standard Model (NMSSM) and the Minimal Supersymmetric Standard Model (MSSM) with a light neutralino ($M_{\tilde{\chi}_1^0} \leq 62.5$ GeV) where the SM-like Higgs boson can decay invisibly, the thermal neutralino relic density is smaller than the measured cold dark matter (DM) relic density, and where experimental constraints from LHC searches, flavour physics and DM direct detection are satisfied. We observe allowed regions of parameter space in the NMSSM and the MSSM where the lightest neutralino could have a mass as small as ~ 1 GeV and ~ 35 GeV, respectively, while still providing a significant component of relic dark matter. We then examine the prospects of probing the NMSSM and the MSSM with a light neutralino via invisible Higgs boson width measurements at the ILC. We also explore the complementarity between future direct detection experiments and Higgs boson invisible width measurement at the ILC. In the NMSSM with light neutralino, we find that the ILC will be able to probe parameter space points in the $M_{\tilde{\chi}_1^0} < 10$ GeV region which may be forever outside the reach of DM detectors. We also find that the ILC will be able to probe a considerable fraction of parameter space points which fall outside the projected reach of future DM detectors in the $10 \text{ GeV} < M_{\tilde{\chi}_1^0} < 62.5$ GeV region.

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