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A proper reduct of the real projective hierarchy that defines sets in each projective level

There exist closed $E \subseteq \mathbb{R}$ such that $(\mathbb{R}, +, \cdot, E)$ defines a Borel isomorph of $(\mathbb{R}, +, \cdot, \mathbb{N})$, and so defines sets of every projective level, yet does not define $\mathbb{N}$, even when $(\mathbb{R}, +, \cdot, E)$ is further expanded by all subsets of every cartesian power of E.

Joint work with Harvey Friedman.