We provide a “soft” proof of the mean convergence of averages under a polynomial abelian group action on a Hilbert space (a special case of current results due to Tao, Host-Kra and Walsh). We use the formalism of continuous logic via Henson structures, and introduce a suitable class of structures consisting of a Hilbert space $\mathcal{H}$ endowed with a polynomial action of an (abelian) group $G$ by unitary automorphisms of $\mathcal{H}$. For fixed $G$ (plus a notion of “averaging over $G$” as given by a fixed Følner net $\{G_j\}$ therein) we show, roughly speaking, that the class of all structures $(\mathcal{H}, G, \{G_j\}, f)$ such that $f : G \to U(\mathcal{H})$ is a Leibman polynomial of degree at most $d$ is axiomatizable in a suitable Henson language. As a by-product of the compactness of the Henson logic, the theorem is refined gratis to a statement about uniformly metastable convergence (in Tao’s sense). Our approach owes much to Tao’s outline of a nonstandard analysis proof of Walsh’s Theorem. (Received July 18, 2017)