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Adding oscillatory functions to the real field

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We are interested in expanding the real field by oscillatory functions, in particular, those that arise in solving certain kinds of ODEs. Certainly, in some cases (e.g., $\sin x$), we wind up defining \mathbb{Z} (the set of all integers), hence any hope of obtaining useful information via model-theoretic methods is lost. On the other hand, there are some oscillatory functions that do generate well-behaved (in a sense that can be made precise) structures; e.g., $\sin(\log x)$, $x > 0$. I will give a necessary condition on functions f such that $(\mathbb{R}, +, \times, f)$ is o-minimal and $(\mathbb{R}, +, \times, \sin(\log f))$ does not define \mathbb{Z} .