Monomorphisms in categories of modules

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I will give descriptions of monomorphisms in several different categories of modules over rings which do not necessarily have an identity element. Firstly, I will describe monomorphisms in the category of all right modules Mod_R. Secondly, in the category UMod_R, which is the category of all unitary right modules (i.e. right modules M_R satisfying $MR = R$) over an idempotent ring R (i.e. $RR = R$). Then I will look at firm right modules, these are right modules M_R for which the canonical mapping

$$\mu_M\colon\ M \otimes R \to M, \quad \sum_{h=1}^{k} m_h \otimes r_h \mapsto \sum_{h=1}^{k} m_h r_h$$

is bijective. Thirdly, I will give a description of monomorphisms in FMod_R, which is the category of all firm right modules over a firm ring R (i.e. the module R_R is firm). Also, I will show that in the category of firm right modules, the set of subobjects of an object forms a modular lattice. My talk will be based on my master's thesis, that I defended in June 2018, which in turn was influenced by articles [1] and [2].

References

[1] V. Laan, Ü. Reimaa, *Monomorphisms in categories of firm acts*, *being published*.

[2] J. Gonzalez–Ferez, L. Marìn, *Monomorphisms and kernels in the category of firm modules*, Glasgow Math. J. 52A (2010), 83–91.