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Complexity in metallic alloys and compounds

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The lecture will focus on A-B-C ternary alloys, in which the elemental metals A, B and C are chosen in such a way that B-C interactions are repulsive, but A-B and A-C are attractive in the respective binary systems. Such "push-pull alloys" are reminiscent of the well-known push-pull amplifiers designed to amplify electric signals because they amplify complexity in intermetallics, forming complex compounds with tens to thousands atoms per unit cell. Few of them lead to the ultimate degree of complexity, when quasiperiodic order substitutes for crystal periodicity, thus opening the way to the discovery of unprecedented properties such as heat insulation in $Al_{62}Cu_{25}Fe_{13}$ (at.%). Many such compounds are known today, which share the same primary characteristics (the picture may be extended to specific binary alloys by referring to salient features of the electronic density of states). The case of push-pull alloys will be exemplified with data obtained from few in-depth studies of quasicrystal-forming systems such as Al-Cu-Fe or Al-Pd-Mn. Special attention will be placed on the potential usefulness of coatings and composites made thereof. New insight gained on (Gd,Al)-Cu-Fe metallic glasses will also be presented, especially regarding magnetic properties in relation with phase transitions taking place in those glasses upon thermal ageing.