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# Reaction dynamics with exotic nuclei

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**Abstract**

We review the new possibilities offered by the reaction dynamics of asymmetric heavy-ion collisions, using stable and unstable beams. We show that it represents a rather unique tool to probe regions of highly asymmetric nuclear matter (ANM) in compressed as well as dilute phases, and to test the in-medium isovector interaction for high-momentum nucleons. The focus is on a detailed study of the symmetry term of the nuclear equation of state (EOS) in regions far away from saturation conditions but always under laboratory controlled conditions.

Thermodynamic properties of ANM are surveyed starting from non-relativistic and relativistic effective interactions. In the relativistic case, the role of the isovector–scalar $\delta$-meson is stressed. The qualitative new features of the liquid–gas phase transition, "diffusive" instability and isospin distillation, are discussed. The results of ab initio simulations of $n$-rich, $n$-poor, heavy-ion collisions, using stochastic isospin-dependent transport equations, are analyzed as a function of beam energy and centrality. The isospin dynamics plays an important role in all steps of the reaction, from prompt nucleon emissions to the final fragments. The isospin diffusion is also of large interest, due to the interplay of asymmetry and density gradients. In relativistic collisions, the possibility of a direct study of the covariant structure of the effective nucleon interaction is shown. Results are discussed for particle production, collective flows and isotransparency.

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Perspectives of further developments of the field, in theory as well as in experiment, are presented.


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**Contents**

1. Introduction . . . 338
2. Symmetry term effects on compressibility, saturation density and nucleon mean field . . . 342
   2.1. The symmetry term of Skyrme forces . . . 345
      2.1.1. Mean-field and chemical potentials . . . 347
   2.2. Effective masses in neutron-rich matter . . . 349
      2.2.1. Effective masses and Landau parameters . . . 351
      2.2.2. Energy dependence of the Lane potential . . . 352
   2.3. Isospin effects on the momentum dependence of the mean field . . . 353
3. Instabilities in two-component fluids: the liquid–gas phase transition in asymmetric matter . . . 357
   3.1. Thermodynamical study . . . 357
      3.1.1. Isoscalar-like and isovector-like instabilities . . . 360
      3.1.2. Nuclear matter instabilities . . . 361
   3.2. Dynamical analysis . . . 363
      3.2.1. Illustrative results for liquid–gas phase transitions . . . 366
      3.2.2. Coulomb effects on instabilities . . . 366
      3.2.3. Isospin distillation . . . 367
   3.3. Simulation results: heated nuclear matter in a box . . . 369
4. Symmetry term effects on fast nucleon emission and collective flows . . . 373
   4.1. Pre-equilibrium dynamics . . . 373
      4.1.1. Average emission times . . . 374
   4.2. Nucleon–nucleon correlation functions . . . 375
      4.2.1. Isospin momentum dependence . . . 378
      4.2.2. Light clusters . . . 378
   4.3. Collective flows . . . 379
      4.3.1. Definitions . . . 380
      4.3.2. Collective flows at the Fermi energies . . . 381
      4.3.3. Isospin effects around the balance energy . . . 382
      4.3.4. Differential flows . . . 383
   4.4. Effective mass splitting and collective flows . . . 385
      4.4.1. Tranverse flows . . . 385
      4.4.2. Elliptic flows . . . 387
      4.4.3. Changing the stiffness of the symmetry term . . . 389
5. Isospin dynamics at the Fermi energies . . . 390
   5.1. Stochastic BNV transport theory . . . 390
   5.2. Main mechanisms of dissipative collisions: fusion vs. deep-inelastic competition . . . 391
   5.3. Isospin in fragmentation dynamics: survey of experimental results . . . 393
      5.3.1. Isospin equilibration and fragment production . . . 393
      5.3.2. Isospin distillation and isoscaling . . . 394
      5.3.3. Isospin dynamics for neck fragmentation in semiperipheral collisions . . . 395
      5.3.4. Isospin diffusion . . . 397