IMPACT OF DARK MATTER ON STELLAR MIGRATION IN DISK GALAXIES

The CDM cosmological model predicts that galaxies are embedded in extended dark matter (DM) distributions with a specific and (nearly) universal radial profile. Almost all dynamical phenomena in galaxies must be marked by the imprint of dark matter through energy and angular momentum exchanges. This is probably the case of stellar migration in the disk of galaxies.

Migration of galactic disk stars has been invoked as a dynamical mechanism to explain the dispersion of stellar metallicity observed in the solar neighborhood. It could also contribute to the "stellar age – velocity dispersion" relation in the disk. There is a current debate on the gravitational perturbations that are at the origin of stellar migration. These perturbations can be intrinsic (density waves, two-body relaxation, dark matter particles, etc.) or extrinsic (galaxy satellites, encounters, mergers, etc.). For the intrinsic case, two classes of models based on N-body simulations have been proposed:

1) Sellwood & Binney (2002) have shown that spiral waves, possibly transient, have the ability to modify the angular momentum of stars without changing the distribution function, so that the disk does not heat up as a result of these changes. These spiral waves have their own pattern speeds with which stars may resonate. Confirmed by Roškar et al. (2012), they have shown that angular momentum exchanges take place mainly at corotation. Therefore, the *corotation scattering mechanism* might be responsible for stellar migration.
2) Minchev & Famaey (2010), confirmed by Minchev et al. (2011), consider the interactions between a stellar bar and a spiral structure. In this case, at least two patterns exist and the resonances may overlap. *Resonance overlap* introduces additional chaos by increasing the efficiency of orbit scattering, which also modifies the angular momentum of stars.

None of these studies take the interaction between stars and DM particles into account. It is known that angular momentum is absorbed / emitted at vertical resonances between the stellar disk and DM halo. The efficiency of stellar migration must be re-examined in this context.

Objectives of the internship:

1) Extend the Chirikov diffusion rate formalism (recently introduced in stellar dynamics Wozniak 2020a, 2020b) in N-body simulations to include DM interaction using various scenarios: fixed external potential (NFW for instance), live massive particles; Determine the impact of DM on angular momentum, energy and radial action J_R exchanges;

2) Draw all the astrophysical conclusions from the new models, particularly with regard to the impact of the DM on the stellar currents and migrations, the evolution of DM distribution, the degree of dynamical chaos required, etc.

Wozniak H., 2020a, ApJ 889, 81 "Stellar migration in galaxy disks using the Chirikov diffusion rate"
Wozniak H., 2020b, A&A 642, A207 "Diffusion of radial action in galactic discs"
Minchev, I. & Famaey, B. 2010, ApJ, 722, 112
Minchev I., Famaey B., Combes F., …, **Wozniak H.**, 2011, A&A 527, 147
Roškar, R., Debattista, V. P., Quinn, T. R., & Wadsley, J. 2012, MNRAS, 426, 2089
Sellwood, J. A. & Binney, J. J. 2002, MNRAS, 336, 785