Rotation curves of galaxies are often used as a kinematic prober to determine the mass distribution of the different components in the Milky Way. The flat and slightly declining rotation curve of the Milky Way shows differential rotation as the rotation frequency varies with orbital distance. Measuring the Galactic rotation curve toward the inner center and outward toward the edge of our Milky Way has remained a challenge for astronomers. The fact that we as observers in the Milky Way means rotation velocities can only be derived from relative motions of stars and gas clouds, but with the Oort constants, we can estimate the velocity field in the solar vicinity. The Oort constants can be estimated from the variation of stellar motions relative to the Sun in Galactic coordinates at different Galactic longitudes. While multiple measurements on Oort constants have been made, an accurate estimation of the constants requires a complete catalogue of stellar parallax, proper motions and radial velocities, as well as careful consideration on what subsets of stars to use. We focus on using a combination of simulation and observational data from Gaia DR2 to examine the methods used to derive Oort constants to high precision. Gaia DR2 catalogues parallax and proper motions measurements of over 1.6 billion of stars, giving us the most comprehensive sample to calculate the Oort constants.

Assuming a thin Milky Way under cold limit and axisymmetric potential and correcting the solar non-circular velocities about the Local Standard of Rest (LSR), (u0,v0,w0), the line of sight velocity, proper motions in the longitude and latitude directions of stars in the solar nearby region can be expressed in the Oort constants as follows:

In reality, potential perturbation and non-axisymmetric Galactic potential attribute to non circular velocity components of stars, adding deviations from the longitudinal dependency constrained by the Oort constants. Thus, to measure the Oort constants from a large observational dataset, a critical question is what criteria to filter data would give the best subsets of stars to derive the Oort constants. Specifically, what cut off for distance and latitude in Galactic coordinate systems are appropriate for the near Sun and circular motion assumption of Oort constants.

In my senior thesis, we first make a toy model simulation treating stars as test particle to investigate the effects of different galactic distance and galactic latitude cut-off. Stars are sampled from quasiisothermal distribution function of a cold and thin disk (Hdisk = , velocity dispersion = ), and integrated on their orbits for 10Gyr to come to their equilibrium. We found the proper motion in longitude direction for stars within 1 kpc from the Sun and less than 20 degree in their latitude are well described by the Oort constants with the small dispersions. If either the distance or the latitude cut-off is larger, the residuals from the model in EqXX have a strong dependency on the longitude. Compared to the longitudinal proper motion, the line of velocities is more dispersed around the value predicted by EqXX. Similarly, a smaller range of distance and latitude yields the best subset to derive the Oort constants, A, C and K. While the longitudinal proper motion and line of sight velocities are well described by the Oort constants when close to the MW midplane, proper motion in the latitudinal direction

But if we move to an even higher latitude region, stellar intrinsic vertical velocity is larger and dominate the proper motion

We found that non-zero radial and vertical attribute to the deviations and dispersions on the XXX are attributed from non-zero radial and vertical velocity components.

As for Gaia DR2 data, we followed the procedure laid out by the work in XX and XX, grouping the main sequence stars into six color groups after correcting color excess and derived the Oort constants from their mul, vlos and mub. We found it is necessary to constraint the stars within 500pc, a smaller range in our conclusion from the toy model simulation, because XXX. We also found the group with the bluest stars have the smallest deviation from the models predicted by the Oort constants, while the redder color groups have more dispersion in their mul and mub, as well as larger deviation from the equations predicted by the Oort constants. This is expected because redder stars are older and have influenced by non-circular potential perturbation for a longer time, thus their motions are more deviated from the circular and horizontal motions constrained in the Oort constant model. As for the peculiar motion estimated from fitting the Oort constants, their values ….

Past work on using Gaia data to measure the Oort constants disregards radial velocity. We found the available radial velocities for the blue stars with BP-RP-E(BP-RP)<1.2 are abundant enough to estimate the Oort constants to high precision.

Despite the third data release of Gaia is available, lacking spectroscopic measurements such as extinction and color excess prevents us from using the similar methods above to derive the Oort constants in the solar vicinity from this larger catalogue. However, the conclusion from this work can provide some guidance on

Dear Suzanne,

I am sad that I have never gotten to see you in-person this whole year and say a proper goodbye to you. I can’t express how thankful I am to you. You have helped me in so many ways tremendously throughout my four years at Haverford. From being my pre-major advisor when I first came into Haverford, to my first research advisor and to the senior seminar instructor who I relied so much on for my postgraduate applications, you have always been there for me. You are truly inspirational to me as a physicist and researcher. The summer I spent with you doing research and later going to the SCIB2020 conference are such a meaningful landmark in my life.

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It is my fortune to be one of your students.

I have written this following sentence hundreds of times in the emails I have sent to you, but once againl, thank you so much!!!

Dear Andrea,

I have always felt so lucky to be your student and advisee at Haverford. I can’t express how much I am thankful for your teaching and supports in many ways throughout my time at Haverford.

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I must say everything with my thesis started with you helping me to reach out somewhere you