Title	Relating The Origins Of Disk Bar Structure To Star Formation And Stellar Dynamics In Simulations Of Resolved Galaxies [an abstract of dissertation and a summary of dissertation review]
Author(s)	Iles, Elizabeth Jayne Latrobe
Citation	北海道大学. 博士(理学) 甲第15276号
Issue Date	2023-03-23
Doc URL	http://hdl.handle.net/2115/89528
Rights(URL)	https://creativecommons.org/licenses/by/4.0/
Type	theses (doctoral - abstract and summary of review)
Additional Information	There are other files related to this item in HUSCAP. Check the above URL.
File Information	Elizabeth_Iles_abstract.pdf (論文内容の要旨)

Abstract of Doctoral Dissertation

Degree requested: Doctor of Science Applicant's name: Elizabeth Jayne Latrobe ILES

Title of Doctoral Dissertation

Relating The Origins Of Disk Bar Structure To Star Formation And Stellar Dynamics In Simulations Of Resolved Galaxies
（円盤銀河のバー構造の起源とその銀河内の星形成と星の動径移動に与える影響について）

Simulation results initialised from observations of nearby NGC4303 and NGC3627 are used to investigate trends in the star formation and stellar dynamics in the early periods (≤ 1 Gyr) of bar formation and evolution. The effects of galactic structure formation and the mechanisms which may provoke galaxies to evolve into the specific and varied morphologies observable in galaxies throughout the universe remains one of the pressing questions in astronomy today. This work focuses specifically on the bar morphology, characterised by a straight central feature, which can be observed in many -- although not all -- nearby, resolved spiral disk-type galaxies, including the Milky Way. Resolved galaxies are considered prime targets for studying the effects of galactic bar morphology on the star forming ISM. These specific targets are selected based on the criteria of a well-known barred-spiral morphology and different environmental conditions. With the former effectively isolated and the latter considered part of an interacting system, these targets facilitate a comparison between a bar formed in isolation originating from random perturbation and a bar triggered by the tidal forces of interaction with a passing companion.

Three simulated disk galaxies which evolve into late-type barred-spirals are presented, each representative of either isolated bar evolution, motivated by disk instability (IsoB, TideNC) or, a tidally affected, interaction-driven development (TideB). The primary models for comparison are IsoB, a barred disk with isolated evolutionary history which has been tailored to measurements of NGC 4303, and the similarly barred TideB, which is externally driven by the tidal forces of a companion in a minor merger-like interaction and tailored to observations of NGC3627. The third disk, TideNC, is introduced as a counterpart to both cases where the initial condition of the tidally-driven disk is evolved in insolation instead, without the influence of the companion. These simulations are performed with numerical methods in the form of Smoothed Particle Hydrodynamics (SPH) and comprise of live particle components to represent the stars, gas, and dark matter, which are the primary constituents of galaxies.

This research aims to investigate whether the different formation mechanisms capable of producing a central galactic bar also subsequently affect the impact of the bar on the host-galaxy's stellar populations and star forming ISM in significant and discernibly different ways. The simulated disks are probed to consider the spatially and temporally varying trends of bar-related star formation, coupled with the kinematic and dynamical behaviour for these newly-formed stellar populations, as can be traced within the developing disk structures. This has been completed with a view to identifying any significant trends in the stellar populations of these galaxies, as well as to differentiate between effects arising from the different origins of the bar structure throughout the evolution of these features. It is apparent that the presence of a bar significantly impacts the stellar properties in these barred disks. However, it is also apparent that galaxies with visibly similar bars formed in differing isolated and tidally-driven conditions can evolve with clearly distinguishable differences. While general star formation features appear relatively similar in each case, such as the starburst upon bar formation and the slope between surface gas density and star formation rate, some significant differences are identified and attributed to bar origin. There is a noticeable difference in the spatial dependence of star formation efficiency in the tidally driven disc (TideB) when compared with an isolated disc of similar bar morphology (IsoB). This is characterised by a uniquely increasing trend of star formation efficiency with radius and a persistent dearth of star formation along the bar between the centre and each end.

Evolutionary trends which are clearly persistent and distinguishable in simulations -- wherein the entire lifetimes of galaxies can be observed -- are not so simple to determine from the single snapshot observations of real galaxies, due to the relatively long time-scales of galactic evolution. It is, therefore, also necessary to consider whether there exists any means of extracting these features from the observations of real galaxies. By constraining attributes within the measurable stellar properties of disk galaxies, it may be possible to identify characteristics which act as tracers for the specific origins of bar formation. Changes to radial (r) and vertical (z) position, angular momentum (L_z), orbital parameters (eccentricity \& typical radius), and metallicity ($Z_{\rm{metal}}$, [Fe/H] \& [O/Fe]) are assessed independently and relative to stellar age and initial radial position of simulation formed stars in each of the three disks (IsoB, TideB \& TideNC). It is apparent that these properties of the stellar populations also vary in each disk, such as the metallicity distribution in various disk regions and the different propensity of stars to experience inward or outward radial migration and changes to the orbital eccentricity. It is possible to distinguish features which specifically appear to differ based on either the bar formation mechanism or the visible bar morphology.

With these results, it may be possible to trace and identify features which are able to distinguish the evolutionary histories of a barred-disk. Constraining the attributes of these features into measurable properties for observational instruments could then become potential signatures for determining the origins of any resolved barred-galaxy, even post-interaction, while simultaneously developing a wider understanding of galactic bars and their ongoing role in galactic evolution.