*I thank for the review…*

*Assistant Editor's Comments:   
Please remove the references from your abstract.*

*Done*

*Reviewer comments/suggestions :*

*Section2:*

*The section provides a thorough and theoretically rigorous overview of generative models, including VAEs, GANs, normalizing flows, and diffusion models, showcasing a strong grasp of their principles and comparative strengths. This depth of discussion, supported by extensive references, highlights the authors' expertise and provides valuable context for readers interested in the broader methodological landscape. That said, it may be worth considering whether the level of theoretical detail is fully necessary for the paper’s primary audience, especially given its focus on astronomy. Streamlining the discussion to emphasize the practical relevance of these models to astronomy—for instance, how they address challenges like data sparsity, noise, or resolution—could make the section more impactful. Additionally, including a high-level summary of the models and their relevance for readers less familiar with deep learning, as well as expanding on practical implementation details such as data preprocessing, training setup, and computational requirements, would enhance accessibility and ensure the discussion remains tightly aligned with the paper’s goals.*

We thank the referee for recognizing our effort in presenting the theoretical context, and we pay close attention to their suggestions, even though we do not have the same level of expertise in optical galaxy surveys. The mathematical description has been condensed. A new section, “Some Comments”, has been added to motivate the transition from GANs to diffusion score-based models. We present arguments supporting our choice of models and provide a practical rule of thumb that estimates the necessary ratio of the total number of available pixels to model size for effective learning. These arguments serve as general guidelines, and we hope they will be useful to anyone interested in studying other generative models.

As a reminder, Sec. 3.2 provides further details on the model optimization.

*Section3:*

*Page 6, 2nd column, line 5- Mentioning no data compression in diffusion and flow based compared to GANs or VAEs makes the point about latent space size more immediately accessible*

We fully agree and reformulate accordingly the sentence.

*Section 3.1:*

*Not sure why details of Kadkhodai et al sample matter in this study, they can be removed.*

*The cited requirement of 10^5 images for transitioning from memorization to generalization in datasets like CelebA and LSUN Bedroom may not directly translate to galaxy images. Galaxy datasets might exhibit different variability and structural complexity, which could lower the necessary sample size. The relationship between sample size and data complexity has been studied, such as in Liu et al. (2021), where it is demonstrated that less complex distributions require fewer samples to approximate effectively.*

*A bit more description of the data (detailed in Smith et al. 2022) would be helpful. For instance what is the sample size that 10^5 can be used for training, what are the redshift and brightness limits.*

We thank the referee for the suggestions, which have led to a reformulation of the text and a clearer emphasis on the possible outcomes of our experiments. In response, we propose to swap the order of the “The Dataset” and “The Models” sections and first expand the “The Dataset” section according to the referee’s recommendations. We have also provided additional details about the SDSS DR9 dataset (noting that the mention of DR7 was an error, which we take this opportunity to correct). This description is largely reproduced

from Smith et al. (2022). Furthermore, we explicitly emphasize that our choice of dataset is by no means restrictive, and we hope that readers will be encouraged to replicate the experiment using the materials provided in the companion GitHub repository (which was already referenced in the initial submission).

We also appreciate the referee’s comments regarding image complexity. This question arose in our minds prior to conducting the experiment, and we initially expected—perhaps naively—that the transition would occur below the 10^5 threshold determined by Kadkhodaie et al. However, our experimental results indicate that this is not the case, as all models exhibit suboptimal optimization when trained on a smaller number of images. This realization motivated the optimization tests developed in Section 3.3.4 (“Flow-Based Models Tests”) and Section 3.3.5 (“GAN-Based Models Tests”).

To keep the complexity estimation straightforward and within the scope of our framework, we propose a simple approach based on the JPEG compression ratio as a first-order proxy for image complexity. We hope that this fulfils the referee requirement.

VOIR <https://arxiv.org/pdf/1411.7766> pour le Liu et al 2014-15 : The relationship between sample size and data complexity has been studied, including in Liu et al. (2014), which discusses how less complex distributions generally require fewer samples for accurate approximation.

*Section 3.2*

* *The section provides a clear summary of architectures and training configurations, but some choices could use clarification. Were the batch size differences (e.g., 10 for GANs vs. 32 for Glow) and resizing to 128×128 enforced by the existing architectures? If so, would adjusting these configurations or building tailored architectures better suited to the data help ensure that such choices do not affect the comparability of experimental results?*

*Section 3.3.2*

* *column1 line 44- two u-net networks is a bit confusing, maybe mention right at the beginning the difference in training size of the two. Also mention whether this is a u-net in a DDPM or some other denoiser not mentioned before?*
* *last paragraph, "significant implications", maybe mention the implication.*
* *More detail on PSNR might be helpful. For instance, are the galaxy cutouts normalized? Is the PSNR calculated over the entire cutout or specifically on the galaxy region? Could the model learning the background alone significantly affect the PSNR? Finally, is PSNR the most appropriate measure for evaluating the quality of denoising.*

*Section 3.3*

* *In some of the experiments where increasing N from 100 to 100,000 improves generalization, it increases the likelihood of less probable data points being included in the training set. However, instead of attempting to approximate the full data density by brute force, a more efficient approach might involve strategically sampling the data distribution to ensure coverage of the parameter space (e.g., not just morphological parameters shown in figure 5/9, but sizes, ellipticities, noise levels in the background, etc). This could improve generalization without requiring massive datasets, focusing on capturing the range of the distribution rather than replicating its density. Figure 10, is there a sharp cut at the left side of the histograms or is xrange chosen for a reason*

*Section 4*

* *It is mentioned that the three models are compared while they are not really compared to each other directly. For example, are certain models (e.g., Glow or DDPM) inherently better suited to capturing galaxy-specific features such as faint structures, noise properties, or morphological diversity?*