Learning to correct for atmospheric seeing from solar observations

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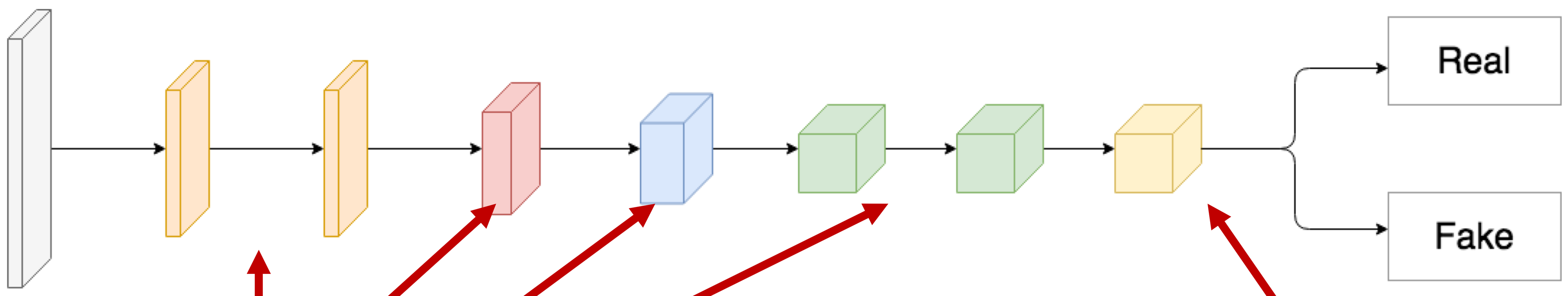
1. Introduction

- Atmospheric seeing is ubiquitous in ground-based astronomy[1].
- We propose a post-processing correction for seeing using a machine learning algorithm known as generative adversarial network[2] (GAN).
- This provides a kernel-free deblurring technique.
- In models assuming some blur kernel explicitly it is hard to deal with occluded (optically thick) regions without a complex kernel estimation[9]. This is avoided in our model.

Overview

- We employ a post-processing machine learning algorithm to correct for atmospheric seeing.
- The model is trained on data from SOT on Hinode which is imprinted with an artificial blur.
- The model is then applied to data from CRISP with promising results.



D divides the generated and true images into 64, 128, 256, 512 segments, respectively (different colours represent the number of segments produced).

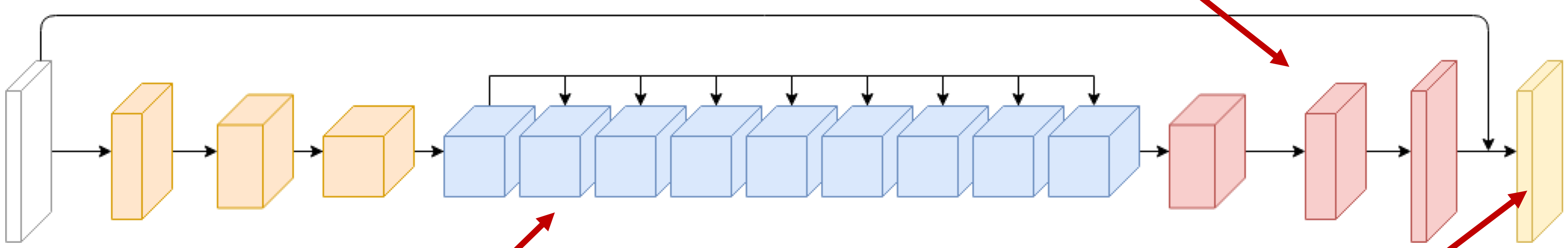
Fig. 1: Discriminator[4,6] (D)

D classifies each segment as real or fake.

G reassembles the segments.

2. Discriminator and Generator

- There are two parts to a GAN: discriminator (D) and generator (G).
- The goal of the generator is to fool the discriminator into thinking the data that it has created is real.
- The discriminator wants to classify whether or not data is real.
- The two play a game against each other and train simultaneously.



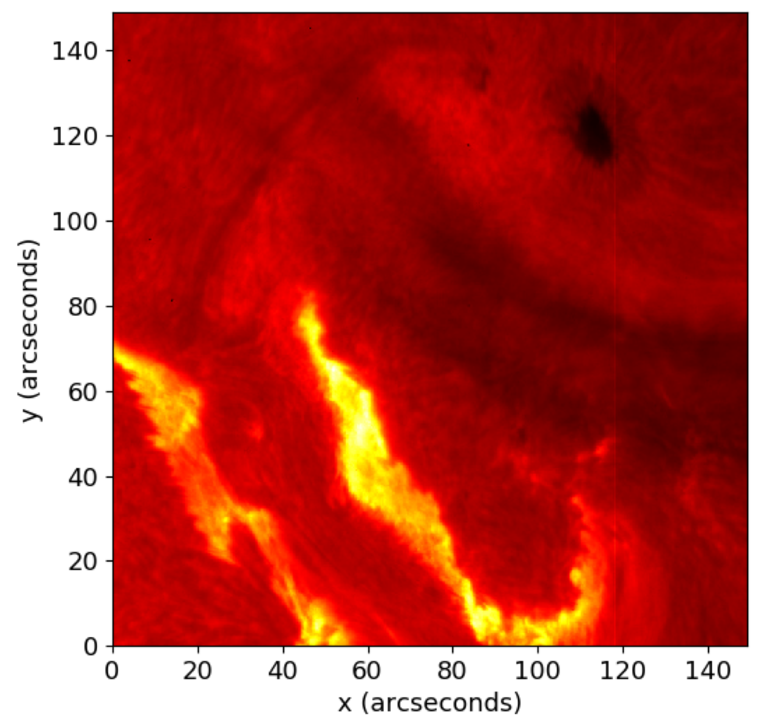
G learns the difference between the sharp and blurred image[8].

Fig. 2: Generator[3,5] (G)

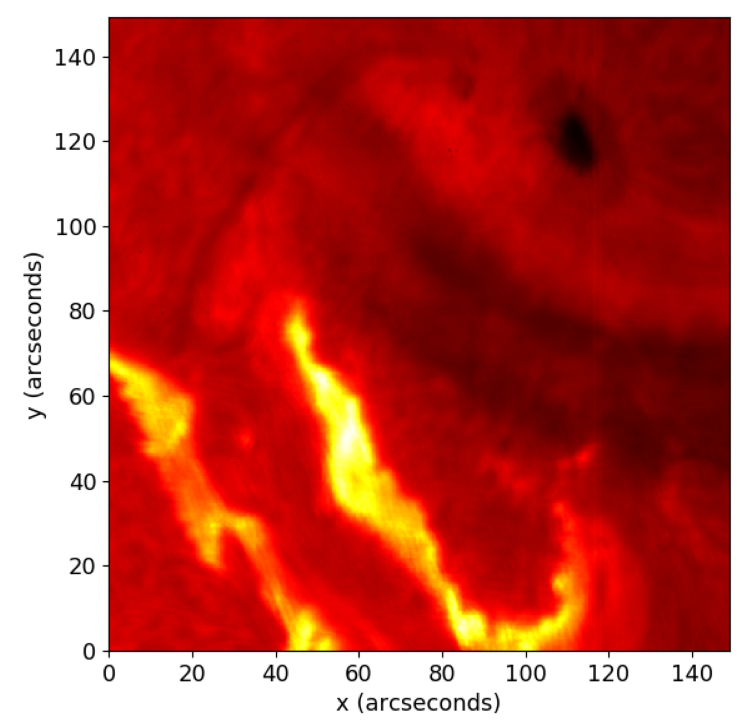
G adds what it has learnt to the blurry image for comparison with the sharp image.

3. Blur Model

Fig. 3: SOT[7] image pre- and post-blurred



Blur image via randomly offsetting the image w.r.t. itself twice and averaging.



4. CRISP Ca II 8542Å Correction

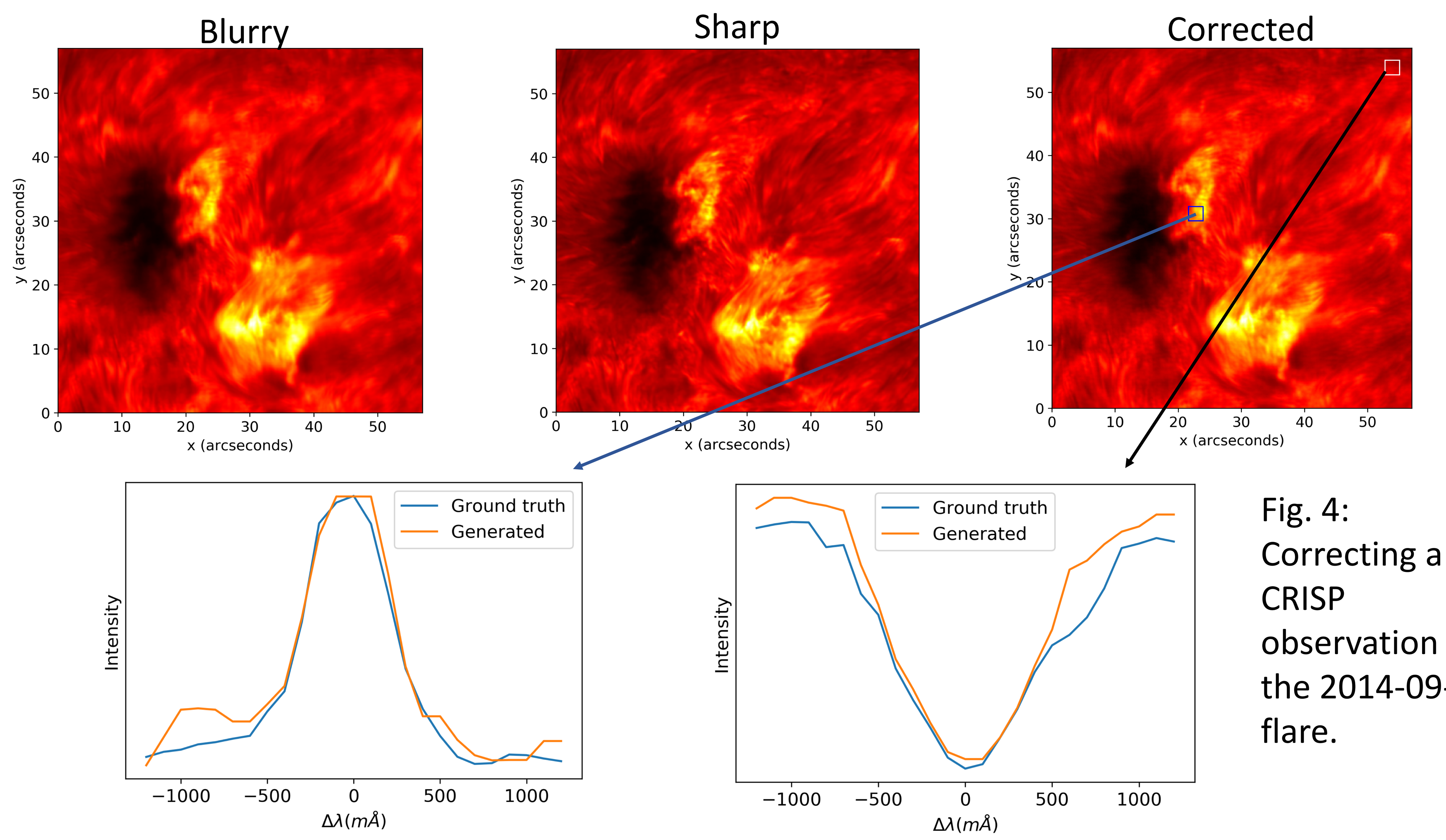


Fig. 4: Correcting a CRISP observation of the 2014-09-06 flare.

5. Conclusion

- Reconstructs lines well from CRISP data.
- This shows that the image deblurring works perceptually and preserves spectral integrity.
- This implies that the method can be used to correct for atmospheric seeing.

References

[1] Davies, R. and Kasper, M. (2012) *Annual Reviews of Astronomy and Astrophysics,* 50:350-351.
[2] Goodfellow, I. et al. (2014). *ArXiv e-prints.*
[3] Kupyn, O. et al. (2017). *ArXiv e-prints.*
[4] Isola, P. et al. (2017). *Proceedings – 30th IEEE Conference on Computer Vision and Pattern Recognition.*
[5] Lecun, Y. et al. (1998). *Proceedings of the IEEE,* 86(11):2278-2324.
[6] Li, C. and Wand, M. (2016). *Lecture Notes in Computer Science,* 9907 LNCS:702-716.
[7] Tsuneta, S. et al. (2008). *Solar Physics,* 249(2):167-196.
[8] He, K. et al. (2015). *ArXiv e-prints.*
[9] Nah, S. et al. (2016). *ArXiv e-prints.*