

PhysicsNeRF: Physics-Guided 3D Reconstruction from Sparse Views

PhysicsNeRF is a physically grounded framework for 3D reconstruction from sparse views, extending Neural Radiance Fields (NeRFs) with four complementary constraints: depth ranking, RegNeRF-style consistency, sparsity priors, and cross-view alignment. While standard NeRFs fail under sparse supervision, PhysicsNeRF employs a compact 0.67M-parameter architecture and achieves 21.4 dB average PSNR using only 8 views, out-performing the state-of-the-art baselines. A generalization gap of 5.7–6.2 dB is consistently observed and analyzed, revealing fundamental limitations of sparse-view reconstruction. PhysicsNeRF enables physically consistent, generalizable 3D representations for agent interaction and simulation, and clarifies the expressiveness–generalization trade-off in constrained NeRF models.

M Rayan Barhdadi¹, Hasan Kurban², Hussein Alnuweiri²

¹ Department of Electrical and Computer Engineering, Texas A&M University, Doha, Qatar

² College of Science and Engineering, Hamad Bin Khalifa University, Doha, Qatar



01 What's the Problem?

With ≤ 8 posed images—common in phone or drone scans—leave vanilla NeRF under-constrained, so it memorises inputs and hallucinates the rest.

(A) Needs > 20 views; otherwise geometry blurs or vanishes.

(B) Recent fixes (RegNeRF, DietNeRF, SparseNeRF) add heuristics yet still leave a 5 – 6 dB gap on unseen views, showing physics-free regularisation is not enough.

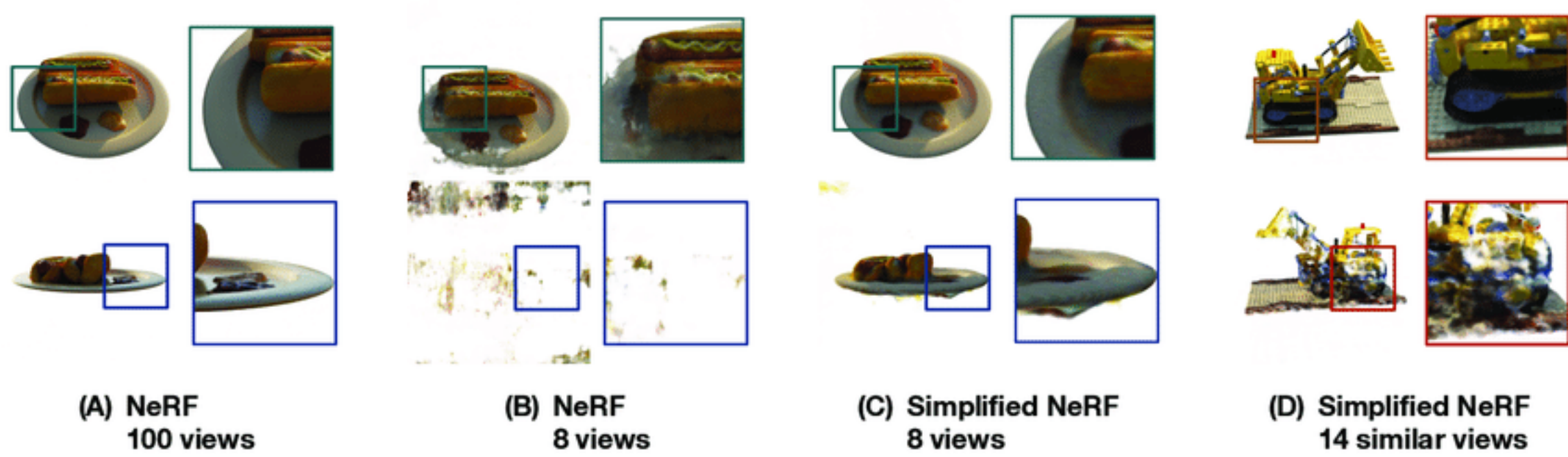


Figure 1: Standard NeRF performance degrades with sparse inputs.

02 Our Approach & Preliminary Results

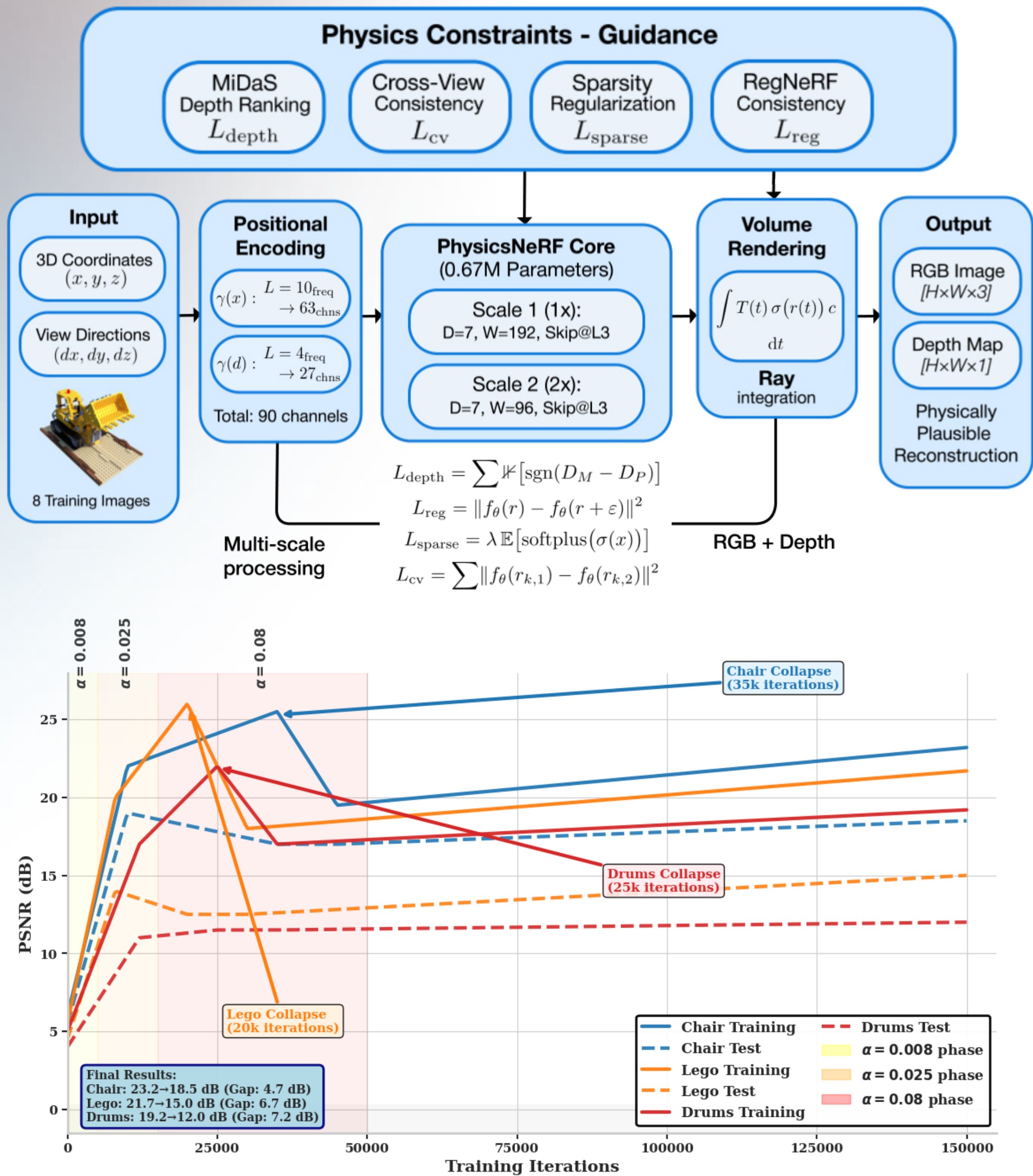


Figure 2: PhysicsNeRF Training Dynamic Evolution

03 Impact & Future Work

- **Accessible Sparse-View 3D**
Enables accurate 3D reconstruction from just 8 images, making high-quality 3D capture more accessible.
- **Future Adaptive Physics Priors & Fusion**
Develop adaptive physics constraints and integrate multi-modal cues for better generalization and fidelity.
- **Full Paper CVPR 26'**

04 Acknowledgments and References

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Contact: rayan.barhdadi@tamu.edu
Web: <https://bmrayan.com>

