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Phase-to-pattern inverse design paradigm for fast realization of functional metasurfaces via transfer learning

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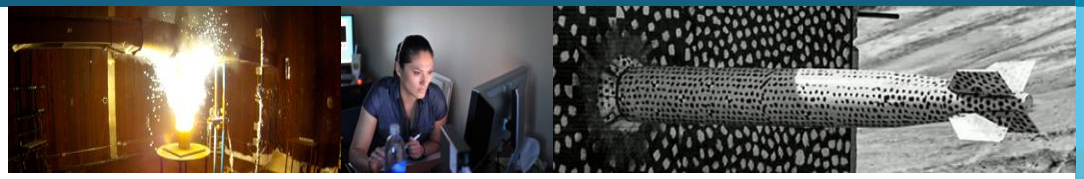

Presented by: Abigail Pribisova

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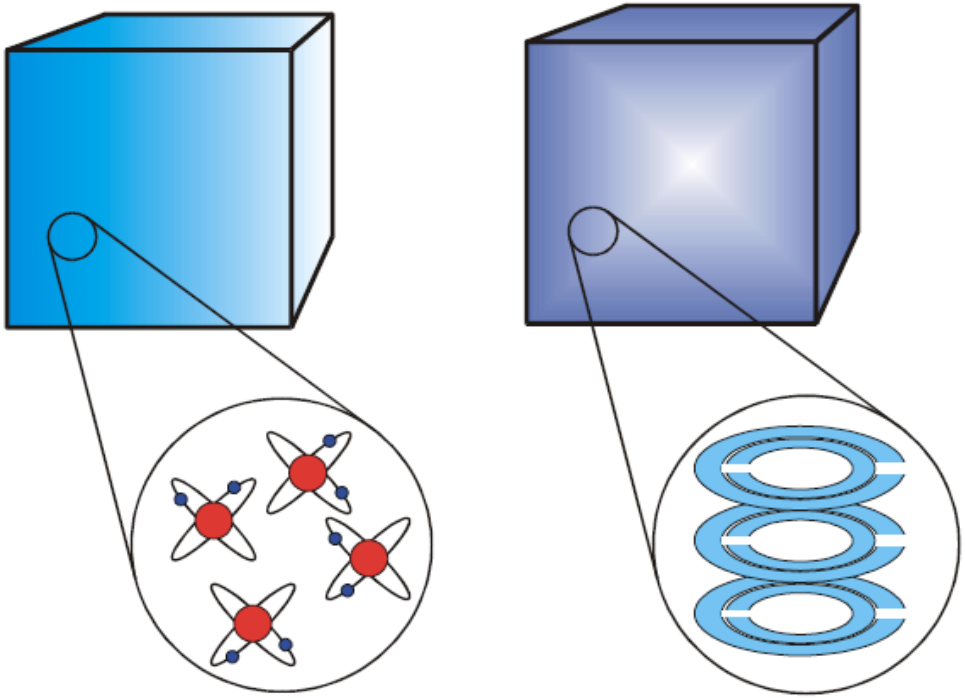
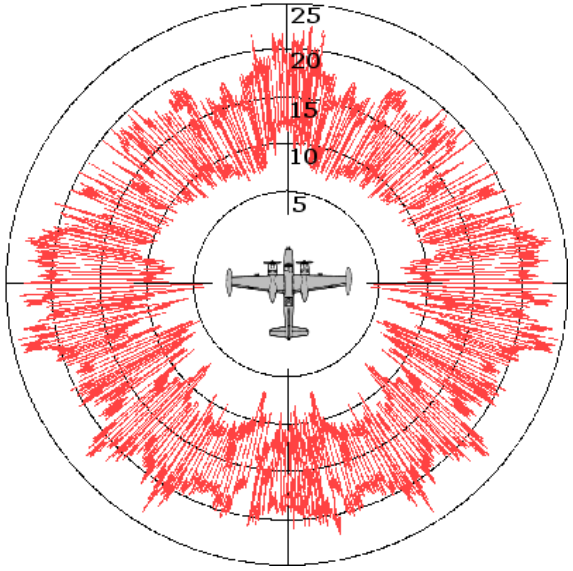
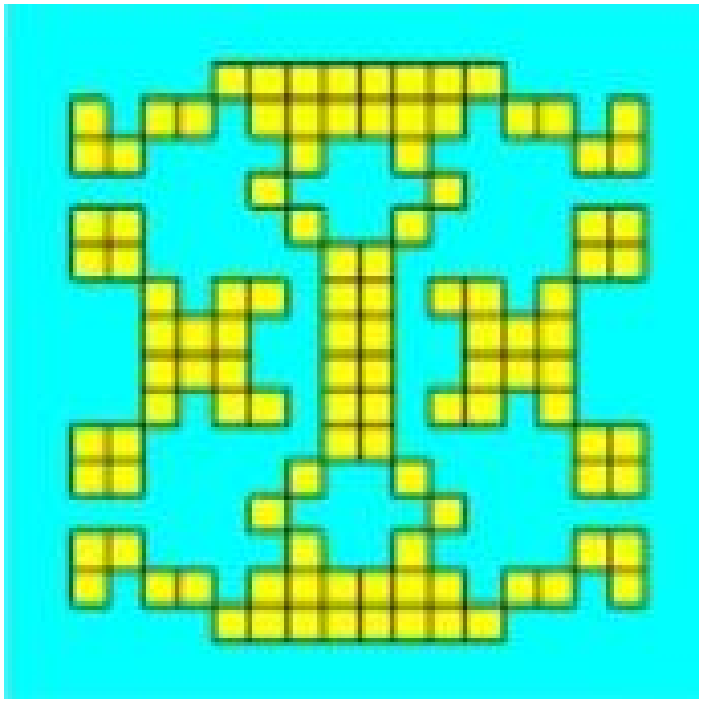
Metasurfaces

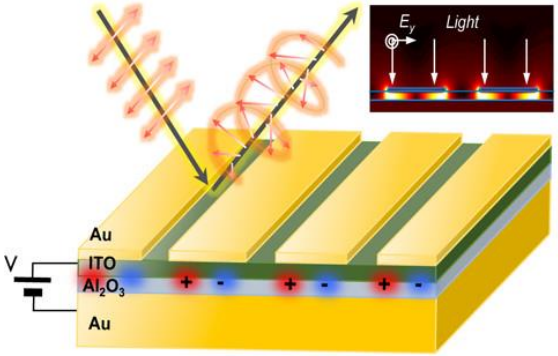
- Light-matter interaction
  - Spectral response
- Applications
- Design process





Training Set Generation



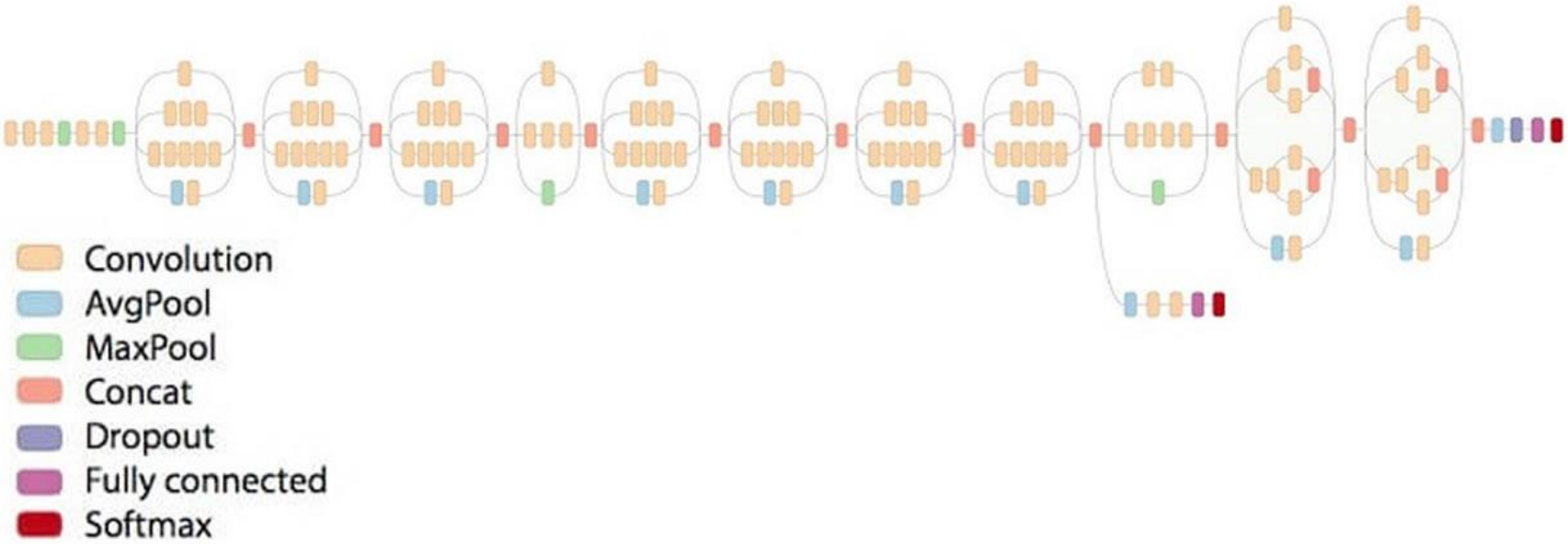


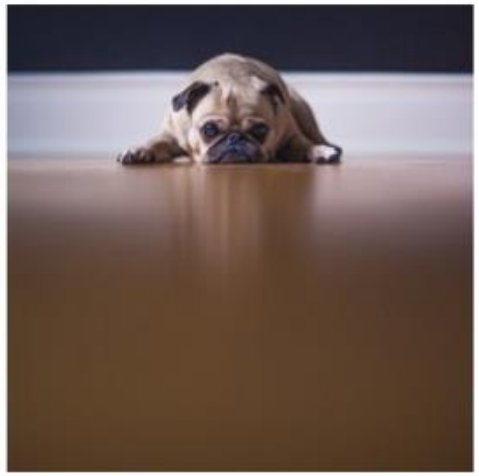
Phase (°)

[[0, 0, 1, 1, 0, 0],
[0, 1, 1, 0, 1, 1],
[1, 1, 1, 0, 0, 0],
[0, 1, 0, 1, 0, 1],
[0, 1, 1, 1, 1, 1],
[0, 0, 0, 0, 0, 1]]

[0, 0, 0, 0, 1, … 0, 0, 0, 0, 0]

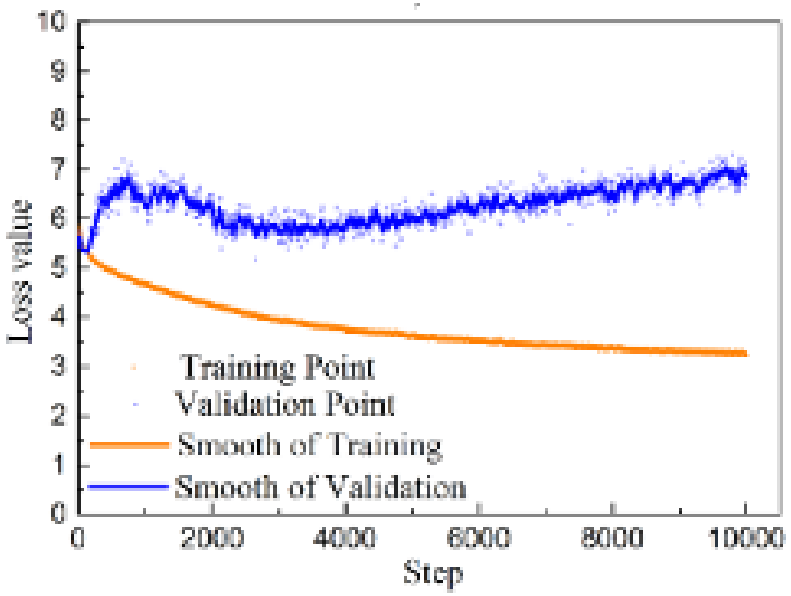
Transfer Learning



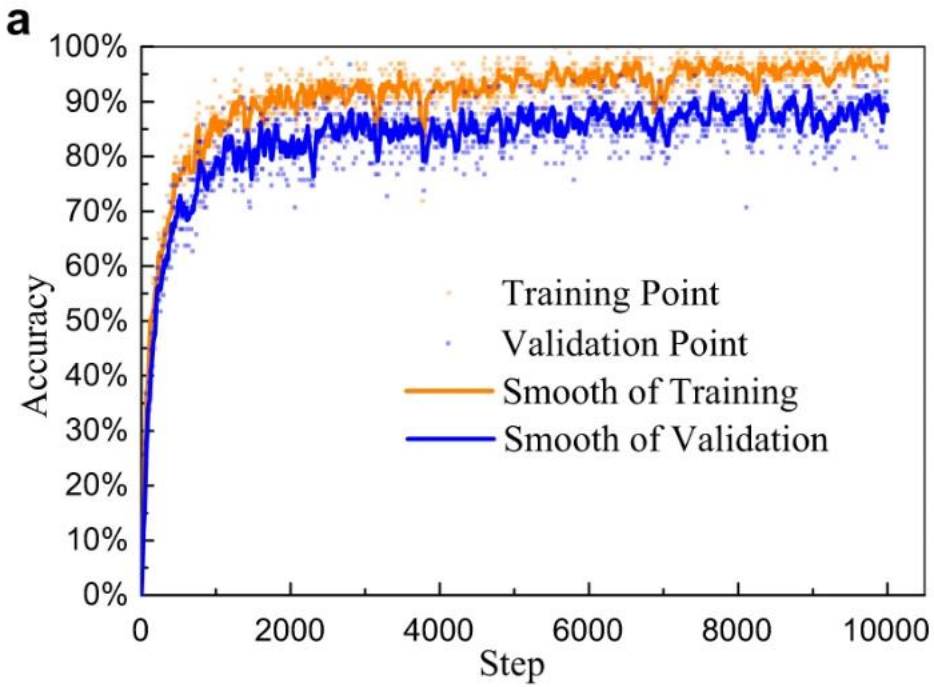


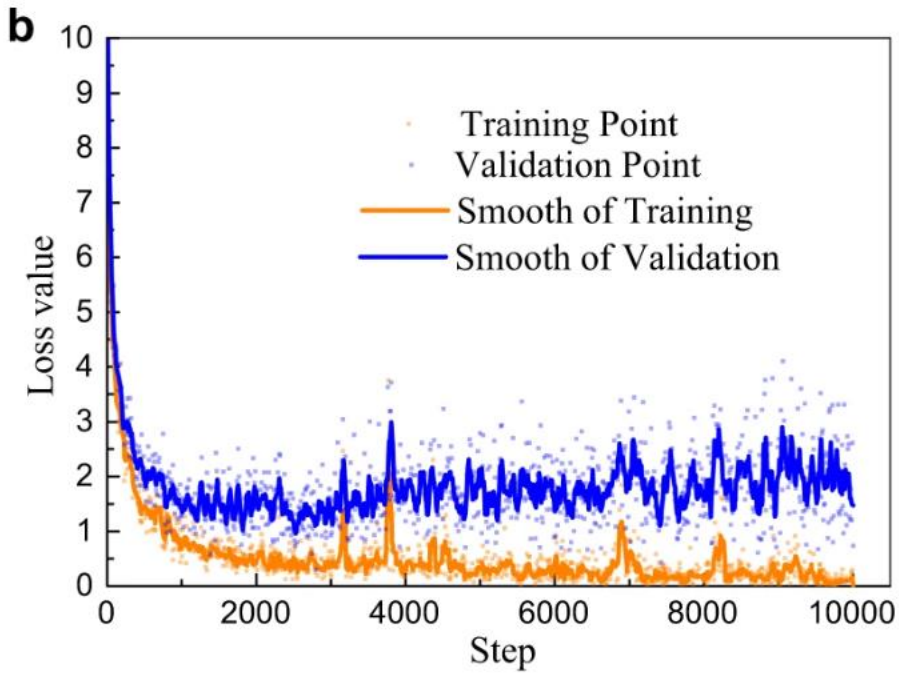
TLN vs. DLN

Model	Samples	Accuracy	Model	Samples	Accuracy
TLN	20,000	89.0%	TLN	50,000	97.9%
DLN	20,000	0.8%	DLN	50,000	10.4%
TLN	30,000	90.2%	TLN	60,000	95.8%
DLN	30,000	8.5%	DLN	60,000	6.7%
TLN	40,000	98.1%	TLN	70,000	95.9%
DLN	40,000	11.0%	DLN	70,000	5.9%

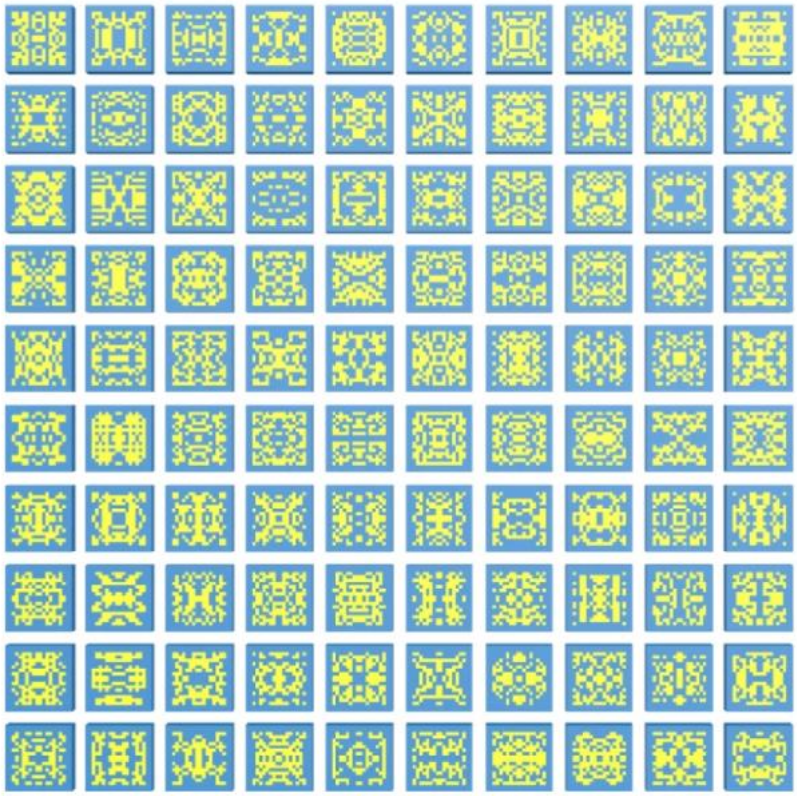


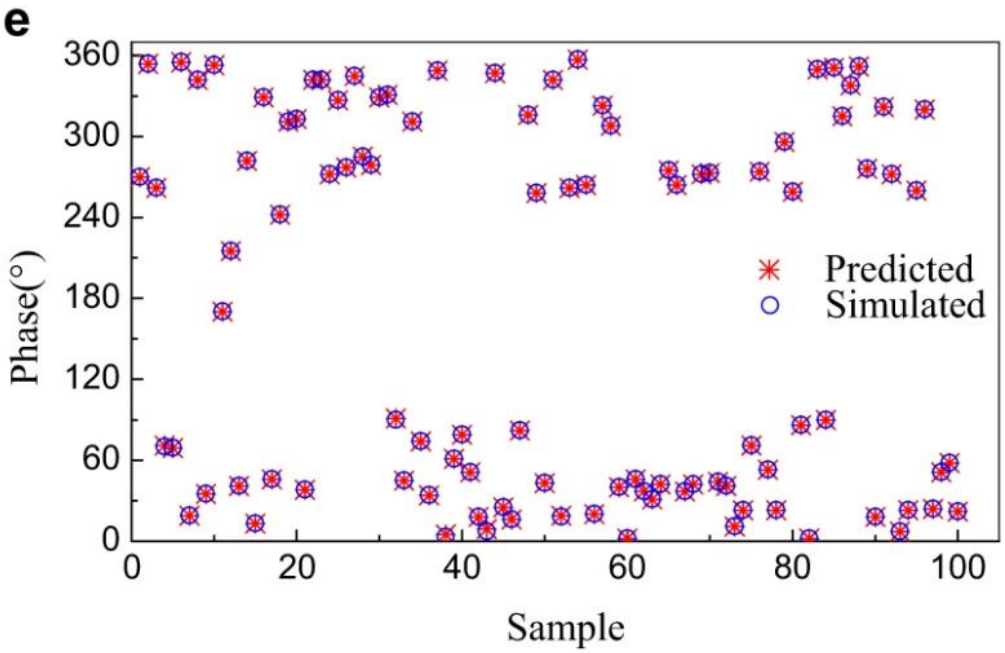
TLN Training/Validation





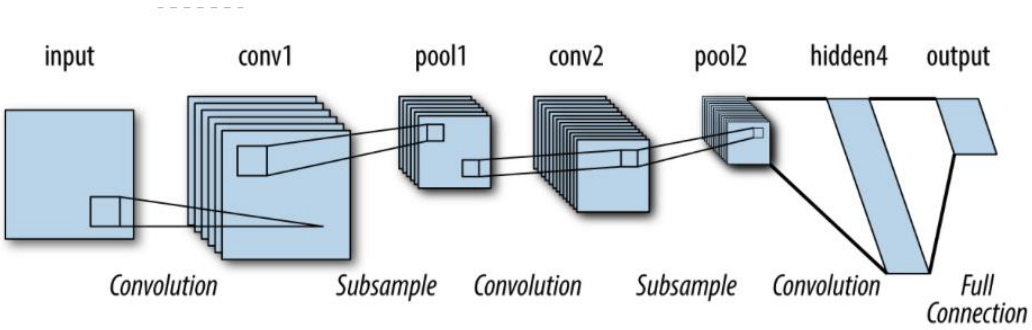
TLN Testing

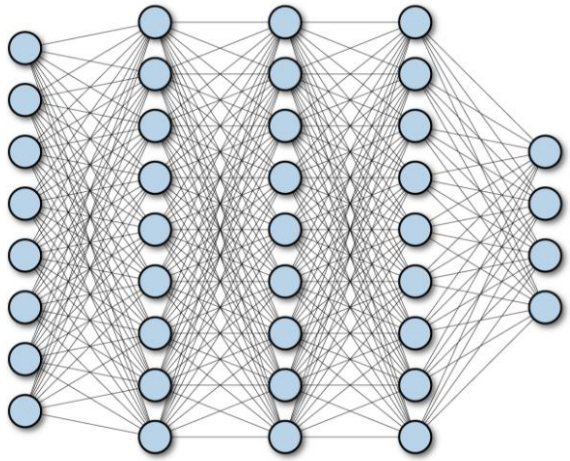



e
360
300
240
180
120
60
0
Phase(°)
0
20
40
60
80
100
Sample
Predicted
Simulated

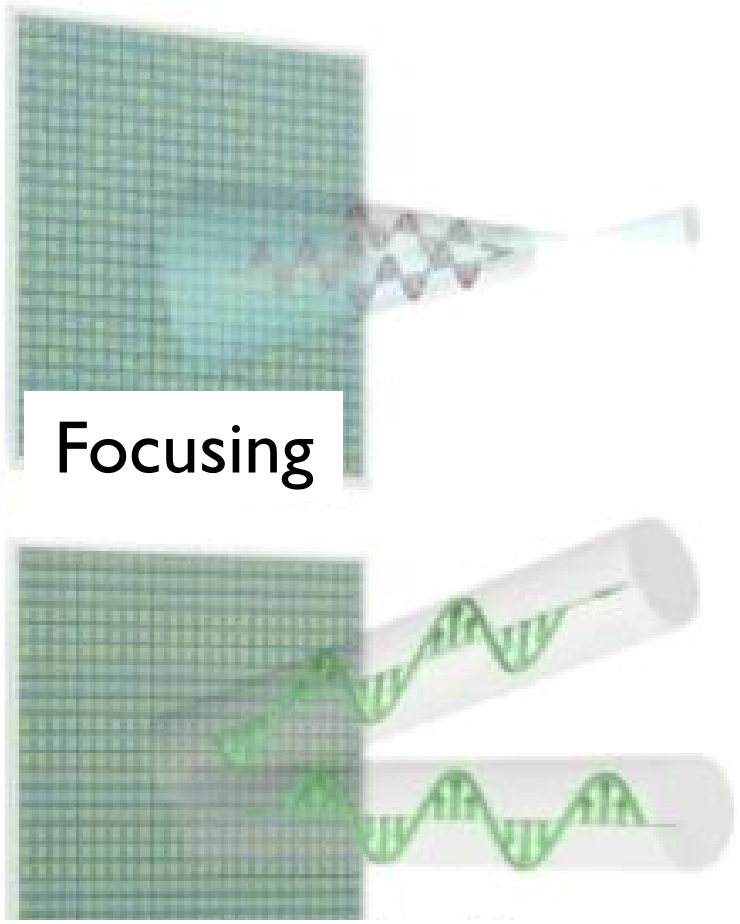
Different Networks

Network	Testing accuracy	Cross entropy loss
3-layer BP	6.85%	8.55
6-layer CNN	0.35%	14.49
MobileNet (TLN)	73%	2.85
Inception V3 (TLN)	89%	0.17



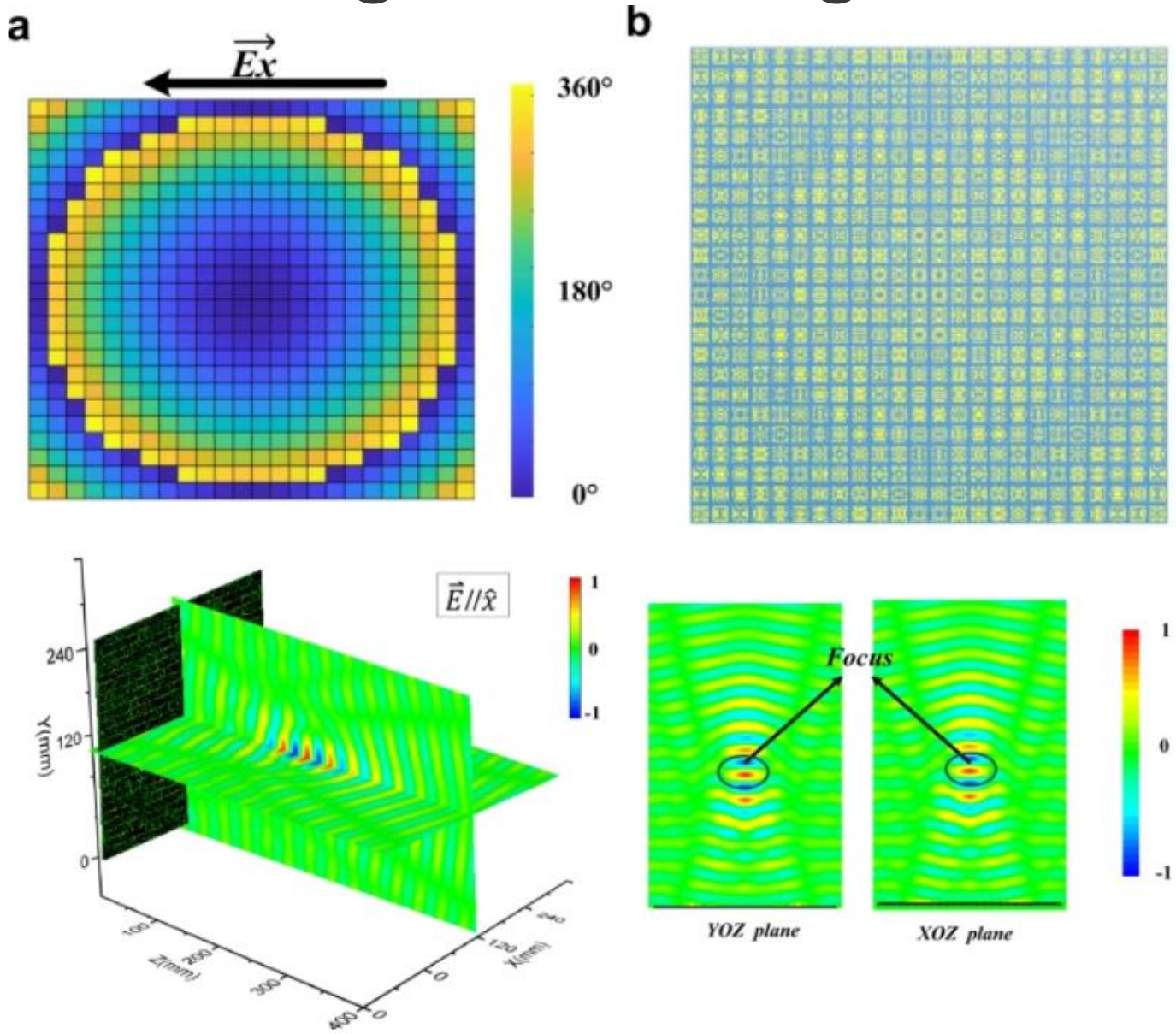


Metasurfaces for Inverse Design

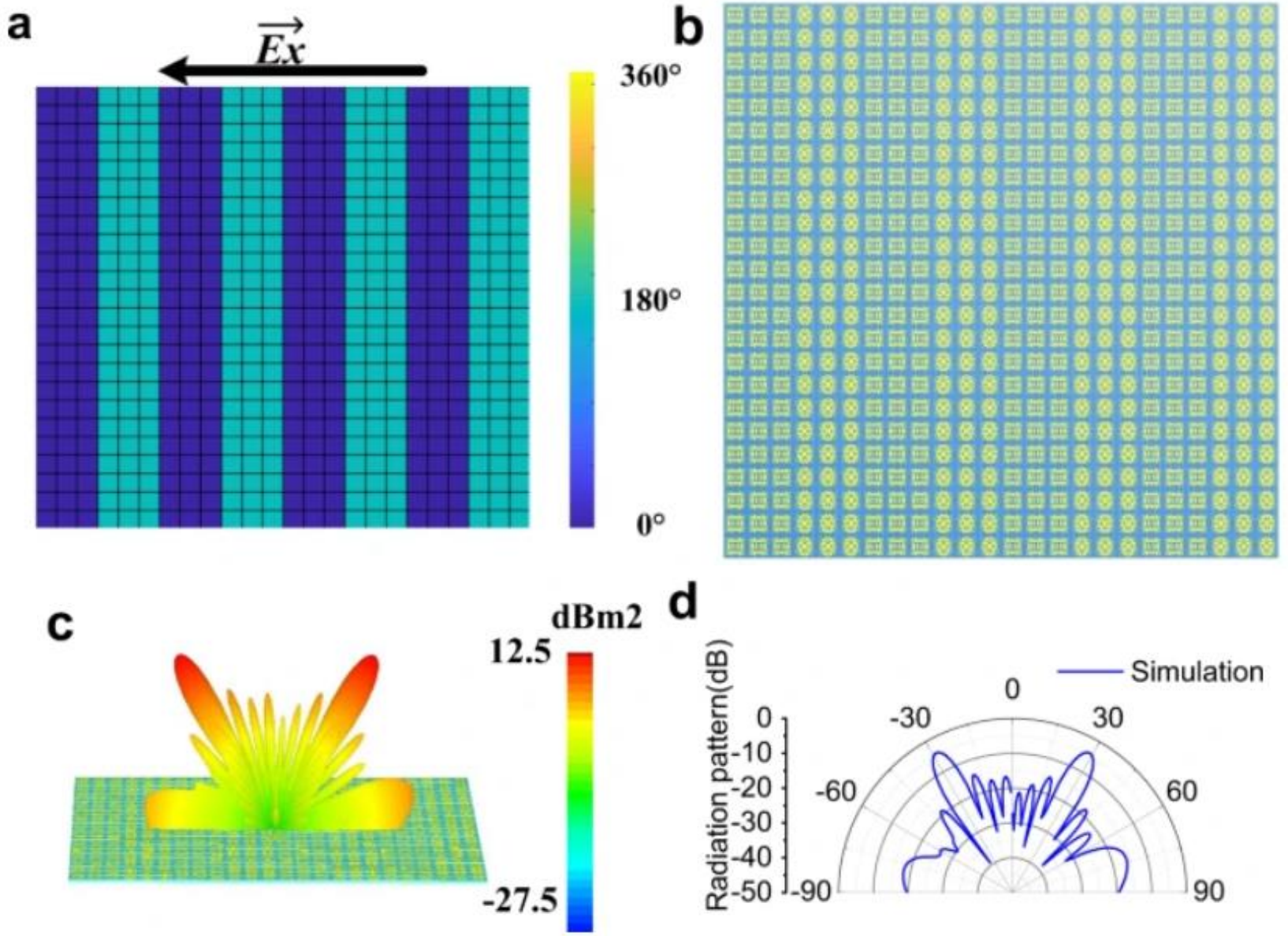


Abnormal Reflection

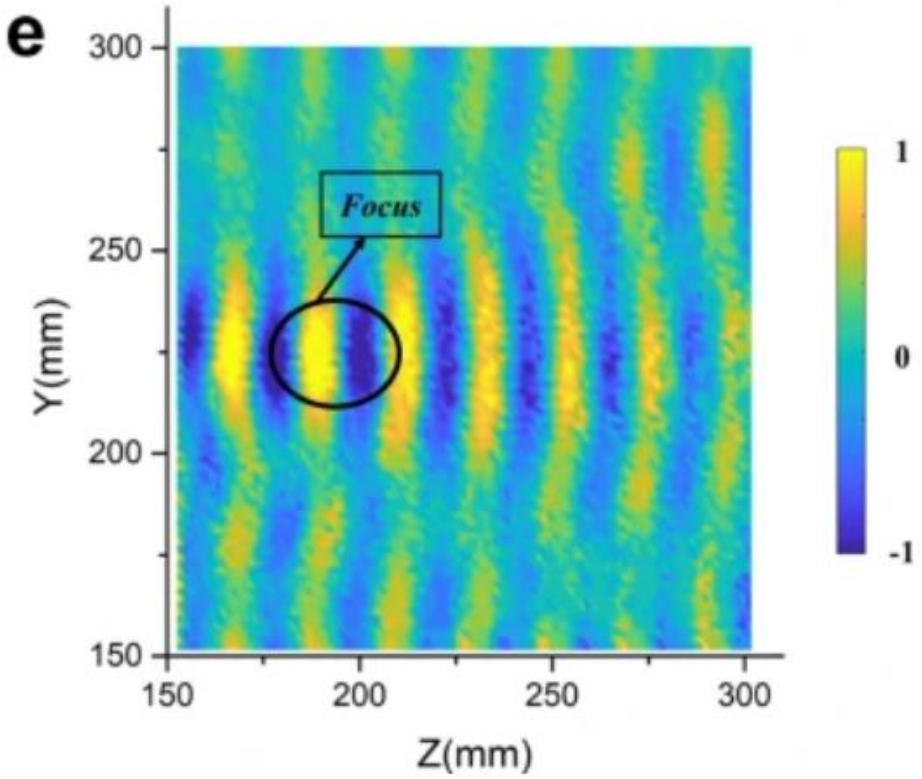
Inverse Design - Focusing

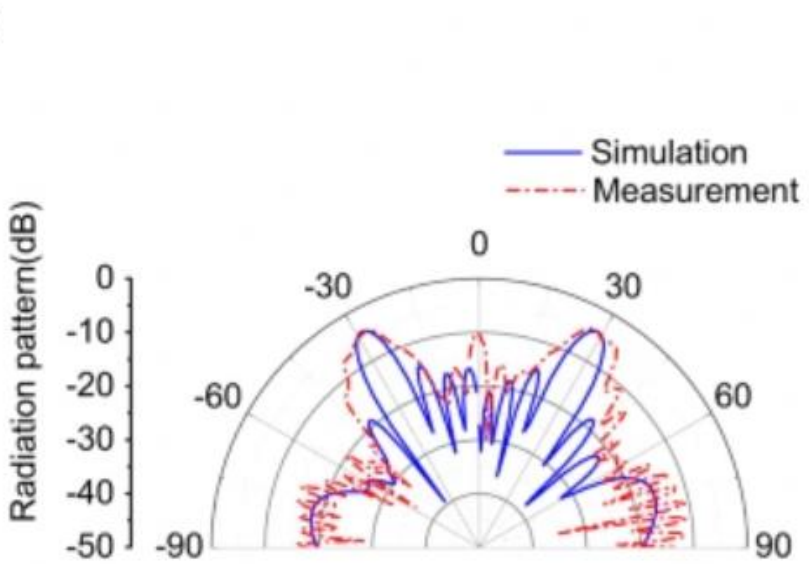


Inverse Design – Abnormal Reflecting



Simulation vs. Reality





Conclusion

- Used TLN to predict phases of meta-atoms with accuracy of 90%
- Used these meta-atom/phase pairs to create library of meta-atoms representing full phase (0 – 360 degrees)
- Construct metasurfaces with certain phase profile from this library
- Verified constructed metasurfaces against simulation and reality
- Thoughts…
  - False advertising?

Works Cited

Qu, S. et al. (2021). Phase-to-pattern inverse design paradigm for fast realization of functional metasurfaces via transfer learning. Retrieved May 26, 2021 from https://www.nature.com/articles/s41467-021-23087-y.