

# Stanford

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## Raag Airan

Assistant Professor of Radiology (Neuroimaging and Neurointervention) and, by courtesy, of Psychiatry and Behavioral Sciences and of Materials Science and Engineering

### CLINICAL OFFICES

- **Radiology Department**

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Stanford, CA 94305

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### Bio

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### CLINICAL FOCUS

- Neuroradiology
- Diagnostic Radiology

### ACADEMIC APPOINTMENTS

- Assistant Professor, Radiology
- Assistant Professor (By courtesy), Materials Science and Engineering
- Assistant Professor (By courtesy), Psychiatry and Behavioral Sciences
- Member, Bio-X
- Member, Maternal & Child Health Research Institute (MCHRI)
- Faculty Fellow, Sarafan ChEM-H
- Member, Wu Tsai Neurosciences Institute

### PROFESSIONAL EDUCATION

- Fellowship: Johns Hopkins University Neuroradiology Fellowship (2016) MD
- Medical Education: Stanford University School of Medicine (2010) CA
- Board Certification: Diagnostic Radiology, American Board of Radiology (2016)
- Residency: Johns Hopkins University Dept of Radiology (2015) MD
- Board Certification: Neuroradiology, American Board of Radiology (2018)
- Internship: Medstar Washington Hospital Center Internal Medicine Residency (2011) DC
- PhD, Stanford University , Bioengineering (2010)

### LINKS

- Airan Lab: <http://airan-lab.stanford.edu>

## Research & Scholarship

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### CURRENT RESEARCH AND SCHOLARLY INTERESTS

Our goal is to develop and clinically implement new technologies for high-precision and noninvasive intervention upon the nervous system. Every few millimeters of the brain is functionally distinct, and different parts of the brain may have counteracting responses to therapy. To better match our therapies to neuroscience, we develop techniques that allow intervention upon only the right part of the nervous system at the right time, using technologies like focused ultrasound and nanotechnology.

## Teaching

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### COURSES

#### 2023-24

- Introduction to Imaging and Image-based Human Anatomy: BIOE 220, BMP 220, RAD 220 (Win)

#### 2022-23

- Introduction to Imaging and Image-based Human Anatomy: BIOE 220, BMP 220, RAD 220 (Win)

#### 2021-22

- Introduction to Imaging and Image-based Human Anatomy: BIOE 220, RAD 220 (Win)

#### 2020-21

- Introduction to Imaging and Image-based Human Anatomy: BIOE 220, RAD 220 (Win)

### STANFORD ADVISEES

#### Doctoral Dissertation Reader (AC)

Madeline Cooper, Charlotte Herber

#### Postdoctoral Faculty Sponsor

Panpan Ma, Mahaveer Purohit, Kanchan Sinha Roy

#### Doctoral Dissertation Advisor (AC)

Matine Azadian, Sedona Ewbank, Alex Hart, Gabriella Muwanga, Brenda Yu

### GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Biophysics (Phd Program)
- Medicine (Masters Program)
- Neuroradiology (Fellowship Program)
- Neurosciences (Phd Program)

## Publications

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### PUBLICATIONS

- **Acoustomechanically activatable liposomes for ultrasonic drug uncaging.** *bioRxiv : the preprint server for biology*  
Purohit, M. P., Roy, K. S., Xiang, Y., Yu, B. J., Azadian, M. M., Muwanga, G., Hart, A. R., Taoube, A. K., Lopez, D. G., Airan, R. D.  
2023
- **Oscillatory effects of ketamine using focused ultrasound sensitive liposomes**  
Yu, B., Taoube, A. K., Airan, R. D.  
CELL PRESS.2023: 540A

- **Oscillatory effects of ketamine using focused ultrasound sensitive liposomes.** *Biophysical journal*  
Yu, B., Taoube, A. K., Airan, R. D.  
2023; 122 (3S1): 540a
- **Noninvasive ultrasonic induction of cerebrospinal fluid flow enhances intrathecal drug delivery.** *Journal of controlled release : official journal of the Controlled Release Society*  
Aryal, M., Azadian, M. M., Hart, A. R., Macedo, N., Zhou, Q., Rosenthal, E. L., Airan, R. D.  
2022
- **Changes In The Cerebello-thalamo-cortical Network After MR-guided Focused Ultrasound Thalamotomy.** *Brain connectivity*  
Thaler, C., Tian, Q., Wintermark, M., Ghanouni, P., Halpern, C., Henderson, J., Airan, R., Zeineh, M., Goubran, M., Leuze, C., Fiehler, J., Butts Pauly, K., McNab, et al  
2022
- **Deep-fUS: A deep learning platform for functional ultrasound imaging of the brain using sparse data.** *IEEE transactions on medical imaging*  
Di Ianni, T., Airan, R. D.  
2022; PP
- **Mu opioid receptor activation mediates (S)-ketamine reinforcement in rats: implications for abuse liability** *Biological Psychiatry*  
Levinstein, M. R., Carlton, M. L., Di Ianni, T., Ventriglia, E. N., Rizzo, A., Gomez, J. L., Budinich, R. C., Shaham, Y., Airan, R. D., Zarate Jr, C. A., Bonaventura, J., Michaelides, M.  
2022
- **Using Passively Detected Acoustic Signals to Characterize Ultrasound Gated Nanoparticles**  
Singh, A., Xiang, Y., Sigona, M., Purohit, M., Hart, A., Hosseini-Nassab, N., Airan, R., Caskey, C., IEEE  
IEEE.2021
- **Ultrasonic Drug Uncaging for Noninvasive Targeted Neuropsychopharmacology**  
Airan, R.  
SPRINGER NATURE.2020: 22
- **Histologic evaluation of activation of acute inflammatory response in a mouse model following ultrasound-mediated blood-brain barrier using different acoustic pressures and microbubble doses.** *Nanotheranostics*  
Pascal, A. n., Li, N. n., Lechtenberg, K. J., Rosenberg, J. n., Airan, R. D., James, M. L., Bouley, D. M., Pauly, K. B.  
2020; 4 (4): 210–23
- **Focused Ultrasound for Noninvasive, Focal Pharmacologic Neurointervention.** *Frontiers in neuroscience*  
Wang, J. B., Di Ianni, T. n., Vyas, D. B., Huang, Z. n., Park, S. n., Hosseini-Nassab, N. n., Aryal, M. n., Airan, R. D.  
2020; 14: 675
- **CT and CEST MRI bimodal imaging of the intratumoral distribution of iodinated liposomes** *QUANTITATIVE IMAGING IN MEDICINE AND SURGERY*  
Chen, Z., Li, Y., Airan, R., Han, Z., Xu, J., Chan, K. Y., Xu, Y., Bulte, J. M., van Zijl, P. M., McMahon, M. T., Zhou, S., Liu, G.  
2019; 9 (9): 1579-+
- **CT and CEST MRI bimodal imaging of the intratumoral distribution of iodinated liposomes.** *Quantitative imaging in medicine and surgery*  
Chen, Z., Li, Y., Airan, R., Han, Z., Xu, J., Chan, K. W., Xu, Y., Bulte, J. W., van Zijl, P. C., McMahon, M. T., Zhou, S., Liu, G.  
2019; 9 (9): 1579-1591
- **Polymeric perfluorocarbon nanoemulsions are ultrasound-activated wireless drug infusion catheters.** *Biomaterials*  
Zhong, Q., Yoon, B. C., Aryal, M., Wang, J. B., Ilovitsh, T., Baikoghli, M. A., Hosseini-Nassab, N., Karthik, A., Cheng, R. H., Ferrara, K. W., Airan, R. D.  
2019; 206: 73–86
- **Noninvasive Ultrasonic Drug Uncaging Maps Whole-Brain Functional Networks.** *Neuron*  
Wang, J. B., Aryal, M., Zhong, Q., Vyas, D. B., Airan, R. D.  
2018; 100 (3): 728
- **Hearing out Ultrasound Neuromodulation.** *Neuron*  
Airan, R. D., Butts Pauly, K.  
2018; 98 (5): 875–77

- **Optogenetic Control of Intracellular Signaling: Class II Opsins** *OPTOGENETICS: A ROADMAP*  
Ellwardt, E., Airan, R. D., Stroh, A.  
2018; 133: 63–73
- **Diffusion MRI tractography for improved transcranial MRI-guided focused ultrasound thalamotomy targeting for essential tremor.** *NeuroImage. Clinical*  
Tian, Q., Wintermark, M., Jeffrey Elias, W., Ghanouni, P., Halpern, C. H., Henderson, J. M., Huss, D. S., Goubran, M., Thaler, C., Airan, R., Zeineh, M., Pauly, K. B., McNab, et al  
2018; 19: 572–80
- **Neuromodulation with nanoparticles** *SCIENCE*  
Airan, R.  
2017; 357 (6350): 465
- **Noninvasive Targeted Transcranial Neuromodulation via Focused Ultrasound Gated Drug Release from Nanoemulsions.** *Nano letters*  
Airan, R. D., Meyer, R. A., Ellens, N. P., Rhodes, K. R., Farahani, K., Pomper, M. G., Kadam, S. D., Green, J. J.  
2017; 17 (2): 652-659
- **MR-Guided Delivery of Hydrophilic Molecular Imaging Agents Across the Blood-Brain Barrier Through Focused Ultrasound.** *Molecular imaging and biology : MIB : the official publication of the Academy of Molecular Imaging*  
Airan, R. D., Foss, C. A., Ellens, N. P., Wang, Y., Mease, R. C., Farahani, K., Pomper, M. G.  
2017; 19 (1): 24-30
- **Factors affecting characterization and localization of interindividual differences in functional connectivity using MRI** *HUMAN BRAIN MAPPING*  
Airan, R. D., Vogelstein, J. T., Pillai, J. J., Caffo, B., Pekar, J. J., Sair, H. I.  
2016; 37 (5): 1986-1997
- **Presurgical brain mapping of the language network in patients with brain tumors using resting-state fMRI: Comparison with task fMRI** *HUMAN BRAIN MAPPING*  
Sair, H. I., Yahyavi-Firouz-Abadi, N., Calhoun, V. D., Airan, R. D., Agarwal, S., Intrapiromkul, J., Choe, A. S., Gujar, S. K., Caffo, B., Lindquist, M. A., Pillai, J. J.  
2016; 37 (3): 913-923
- **Neurovascular Uncoupling in Resting State fMRI Demonstrated in Patients With Primary Brain Gliomas** *JOURNAL OF MAGNETIC RESONANCE IMAGING*  
Agarwal, S., Sair, H. I., Yahyavi-Firouz-Abadi, N., Airan, R., Pillai, J. J.  
2016; 43 (3): 620-626
- **Estimating a graphical intra-class correlation coefficient (GICC) using multivariate probit-linear mixed models** *COMPUTATIONAL STATISTICS & DATA ANALYSIS*  
Yue, C., Chen, S., Sair, H. I., Airan, R., Caffo, B. S.  
2015; 89: 126-133
- **Label-free in vivo molecular imaging of underglycosylated mucin-1 expression in tumour cells** *NATURE COMMUNICATIONS*  
Song, X., Airan, R. D., Arifin, D. R., Bar-Shir, A., Kadayakkara, D. K., Liu, G., Gilad, A. A., van Zijl, P. C., McMahon, M. T., Bulte, J. W.  
2015; 6
- **Neuroinflammation and brain atrophy in former NFL players: An in vivo multimodal imaging pilot study** *NEUROBIOLOGY OF DISEASE*  
Coughlin, J. M., Wang, Y., Munro, C. A., Ma, S., Yue, C., Chen, S., Airan, R., Kim, P. K., Adams, A. V., Garcia, C., Higgs, C., Sair, H. I., Sawa, et al  
2015; 74: 58-65
- **Optogenetics in Freely Moving Mammals: Dopamine and Reward.** *Cold Spring Harbor protocols*  
Zhang, F., Tsai, H., Airan, R. D., Stuber, G. D., Adamantidis, A. R., de Lecea, L., Bonci, A., Deisseroth, K.  
2015; 2015 (8): pdb top086330-?
- **Natural neural projection dynamics underlying social behavior.** *Cell*  
Gunaydin, L. A., Grosenick, L., Finkelstein, J. C., Kauvar, I. V., Fenno, L. E., Adhikari, A., Lammel, S., Mirzabekov, J. J., Airan, R. D., Zalocusky, K. A., Tye, K. M., Anikeeva, P., Malenka, et al  
2014; 157 (7): 1535-1551
- **Human brain atlas for automated region of interest selection in quantitative susceptibility mapping: application to determine iron content in deep gray matter structures.** *NeuroImage*  
Lim, I. A., Faria, A. V., Li, X., Hsu, J. T., Airan, R. D., Mori, S., van Zijl, P. C.

2013; 82: 449-469

- **Genetic tools to manipulate MRI contrast** *NMR IN BIOMEDICINE*  
Airan, R. D., Li, N., Gilad, A. A., Pelled, G.  
2013; 26 (7): 803-809
- **MRI biosensor for protein kinase A encoded by a single synthetic gene** *MAGNETIC RESONANCE IN MEDICINE*  
Airan, R. D., Bar-Shir, A., Liu, G., Pelled, G., McMahon, M. T., van Zijl, P. C., Bulte, J. W., Gilad, A. A.  
2012; 68 (6): 1919-1923
- **Optogenetic interrogation of neural circuits: technology for probing mammalian brain structures** *NATURE PROTOCOLS*  
Zhang, F., Gradinaru, V., Adamantidis, A. R., Durand, R., Airan, R. D., de Lecea, L., Deisseroth, K.  
2010; 5 (3): 439-456
- **Temporally precise in vivo control of intracellular signalling** *NATURE*  
Airan, R. D., Thompson, K. R., Fenno, L. E., Bernstein, H., Deisseroth, K.  
2009; 458 (7241): 1025-1029
- **Brain circuit dynamics** *AMERICAN JOURNAL OF PSYCHIATRY*  
Hu, E. S., Airan, R. D., Vijaykumar, R., Deisseroth, K.  
2008; 165 (7): 800-800
- **Integration of light-controlled neuronal firing and fast circuit imaging** *CURRENT OPINION IN NEUROBIOLOGY*  
Airan, R. D., Hu, E. S., Vijaykumar, R., Roy, M., Meltzer, L. A., Deisseroth, K.  
2007; 17 (5): 587-592
- **High-speed Imaging reveals neurophysiological links to behavior in an animal model of depression** *SCIENCE*  
Airan, R. D., Meltzer, L. A., Roy, M., Gong, Y., Chen, H., Deisseroth, K.  
2007; 317 (5839): 819-823