## Radiative Signatures of Relativistic Reconnection in Blazar Jets

#### lan Christie



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#### Blazar Variability



Multi-wavelength variability lasting from minutes to weeks!



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#### **Other Characteristics**



Jorstad & Marscher 2016

#### Blazar SED: FSRQ

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#### Blazar SED: BL Lac

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#### Can we model blazar emission?





### Magnetic Reconnection & PIC

#### Reconnection can:

- i. accelerate particles to relativistic energy
- ii. produce relativistically moving *plasmoids*
- Is simulated through *first-principles* particle-in-cell (PIC) simulations

(Guo et al. 2014, Sironi et al. 2015 & 2016, Werner et al. 2016, Sironi & Spitkovsky 2014)

#### PIC Simulation of Relativistic Reconnection: density, kinetic energy, magnetic energy



Sironi et al. 2016



#### Magnetic Reconnection: Particle Acceleration

#### Particles are accelerated at:

- i. X-points
- *ii. during mergers of plasmoids (i.e. secondary reconnection)*
- iii. plasmoid compression

(Guo et al. 2014, Sironi et al. 2015 & 2016, Werner et al. 2016, Sironi & Spitkovsky 2014, Petropoulou & Sironi 2018)

#### Particle Evolution with Reconnection Layer



Petropoulou & Sironi 2018



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Petropoulou & Sironi 2018

#### Temporal Evolution of Relativistic Particle Distribution

### Blazar Flares Via Plasmoids

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### Our Emission Model

- Use 2D PIC simulation results of relativistic magnetic reconnection
- PIC governs majority of model parameter few free parameters (e.g. B-field, size of reconnection layer, strength of external radiation fields, orientation of reconnection layer)
- Compute the emission from the entire reconnection layer model BL Lacs & FSRQs



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# Individual Plasmoid Spectra & Light Curves



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### Plasmoid Size Dependence

0.1 - 300 GeV Light Curve



Fast flares, produced by medium-sized plasmoids, appear on top of a slow-evolving envelope developed by the largest plasmoids





Jet Lorentz factor: 12 Size of Reconnection layer: 10<sup>16</sup> cm B-field: 2*G* 

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## Additional Signatures





#### Summary

#### Outlook

- Our fundamentally-built model displays similar spectral features in FSRQs and BL Lacs!
- Requires few free parameters
- Can produce the fast (minutes) timescale and long (days) flares observed in many blazars!

- Numerous comparisons with observations (e.g. PSDs, correlation, flaring statistics) to come!
- PIC simulations of proton-electron & pair plasmas
- Inclusion of Hadronic components within radiative model

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