# Thesis Outline

## Title

Investigation of complex liquid-gas turbulent interfacial flows : A numerical study

## Introduction

#### Multiphase Flows

- Brief description of multiphase flows in nature
- Surface tension dominated flows

#### Fragmentation

- Brief description of fragmentation
- Importance of drop size distributions

#### Numerical Platforms

- PARIS Simulator
- Basilisk

## Part A : Numerical Development

#### Chapter 1 : Methodology

1. Governing Equations
    - Conservative vs. Non-Conservative Formulations
    - Description of Operators
    - Evolution of phase-characteristic function
    - Material Properties
2. Interface Tracking
    - Volume-of-Fluid + PLIC reconstruction
    - Flux Computation : CIAM and WY
3. Time Marching
    - Spatio-Temporal Discretization
    - Pressure-Projection Algorithm

#### Chapter 2 : Artificial Atomization : The Falling Raindrop

1. Computational Setup
    - Parameterization : Reynolds, Weber, Bond
2. Exploration of Blowups
    - Combinations of Advection Scheme + Flux Limiter
3. Origin of Numerical Instabilities

- Un-physical Stagnation Pressures

**Chapter 3 : Consistent Mass-Momentum Transport**

1. Principles of Momentum Consistent Schemes
    - Major Iterations in Literature
    - Overview of Methods
    - Our Strategies
2. Consistent Flux Computation
    - Schematic
    - Numerical Stencils
3. Reconstruction on Staggered Cells
    - Half-Fractions Method
    - Sub-Grid Method
4. Sub-Grid Strategy
    - Consistency and Conservation
    - Restriction & Prolongation Operators
5. Summary of Methods
    - Flowchart : Half-Fractions Method
    - Flowchart : Sub-Grid Method

**Chapter 4 : Numerical Benchmarks**

1. Static Droplet
    - Setup
    - Decay of Spurious Currents
    - Spatial Convergence
2. Moving Droplet
    - Setup
    - Evolution of Spurious Currents
    - Spatial Convergence
    - Error Dependence : Laplace & Weber numbers
3. Capillary Wave
    - Setup
    - Comparison with Prosperetti Solution
    - Spatial Convergence
4. Falling Raindrop
    - Setup
    - Temporal Evolution : KE, Mass, MOI
    - Convergence of Velocity & Acceleration

## Part B : Physics of Fragmentation

**Chapter 5 : Ligament Mediated Paradigm**

1. Mechanism of Drop Formation

- Disintegration of Jets & Shear Layers
- Expansion of Sheets
- Effervescent Atomization
- Drop Impacts

2. Theories of Fragmentation
    - Cascade Mechanism : Log-Normal
    - Corrugation-Coalescence Mechanism : Gamma

**Chapter 6 : Droplet Generation in Corrugated Ligaments**

1. Numerical Setup
    - Platform : Basilisk
    - Computational Schematic
    - Random Surface Generation
    - Parameterization
2. Ligament Breakup
    - 3D vs 2D Axisymmetric
    - Effect of Spatial Resolution
    - Effect of Droplet Removal
    - Effect of Corrugation Amplitude
    - Effect of Ohnesorge Number
    - Effect of Cut-Off Wavenumber
    - Quantization of Unstable Wavenumbers

**Chapter 7 : Statistics of Drop Sizes**

1. Monte Carlo Approach to DNS
    - Characterization of Ligament Ensembles
2. Millimeter Scale Ensembles
    - Diameter Distributions
    - Mass Distributions
    - Equivalent Diameters
    - PDF of Large Drop Sizes
3. Exploration of Parameter Space
    - Bifurcation Parameter : Corrugation Amplitude
    - Scaling of D/W : Function of Parameter Space
    - *To be added*

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## Conclusions & Perspectives

## Appendix

## Bibliography