TGLFsat2 vs GKW non-linear for high β, low $\hat{s}$

Anass Najlaoui

Introduction

- Integrated modeling needs efficient turbulence models due to computing constraints
- TGLF is designed to address this need

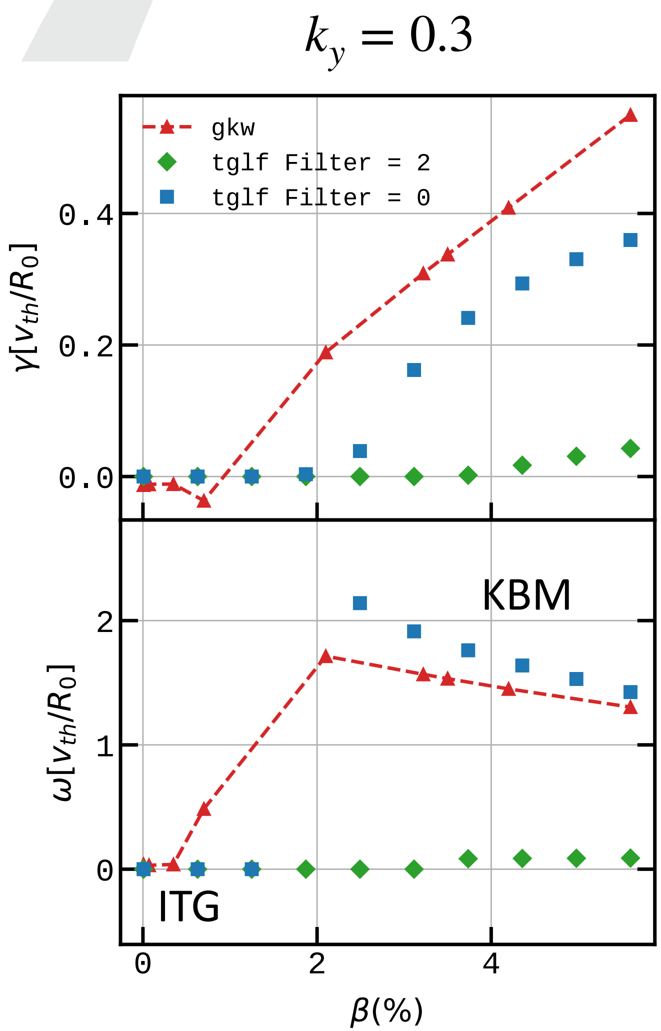
- Validation is crucial before integrating these models
- This presentation compares GKW with TGLF in the High Beta, Low Shear Regime

- Case study JET 75225 Discharge at $\rho = 0.15$

R/L_{Ti}	R/L_{Te}	R/L_{Tc}	R/L_{Ni}	R/L_{Ne}	R/L_{Nc}	$\hat{s}$
4.2	2	4.2	1.67	1.5	-0.7	**0.05**
T_i/T_e	T_c/T_e	n_i/n_e	n_c/n_e	$\beta(\%)$	u	q
1.43	1.43	0.93	0.01	3.2	0.38	1.1

Local plasma input parameters

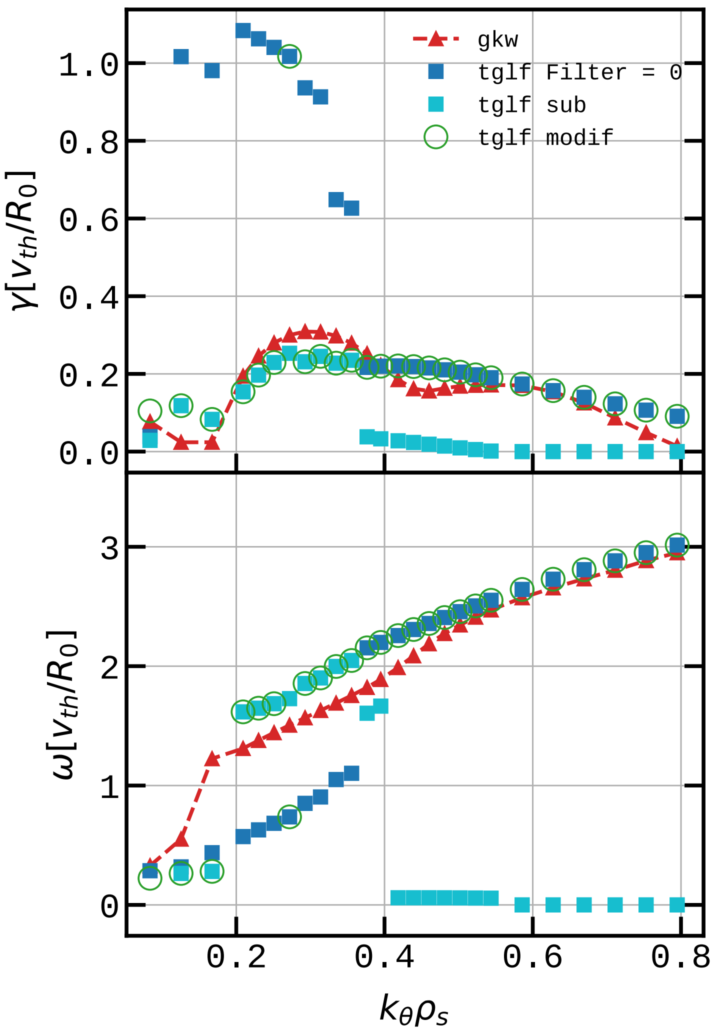
By default, TGLF filters KBMs



- **FILTER input disregards excessively high-frequency modes**
- **Essential for filtering spurious modes**
- **But filters out Kinetic Ballooning Modes**
- **Set Filter to 0 to disable that filtering**
- **If spurious modes appear, they won't be filtered**

Challenges in low k_y very low $\hat{s}$: Unphysical modes

$\beta = 3.19\,\%$



- **At low k_y and $\hat{s}$, unphysical modes appears**
- **Subdominant modes align with expected KBMs**

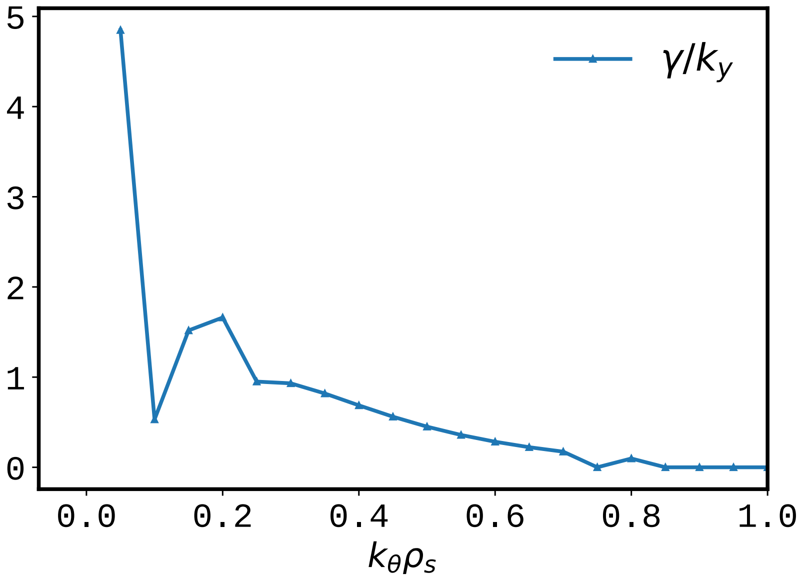
The unphysical modes are characterized by an odd wavefunction structure along the parallel direction

- **A modified TGLF version, excluding odd-structured modes, matches linear GKW predictions**

NBASIS_MIN	NBASIS_MAX	WIDTH	FILTER
2	6	3.0	0.0

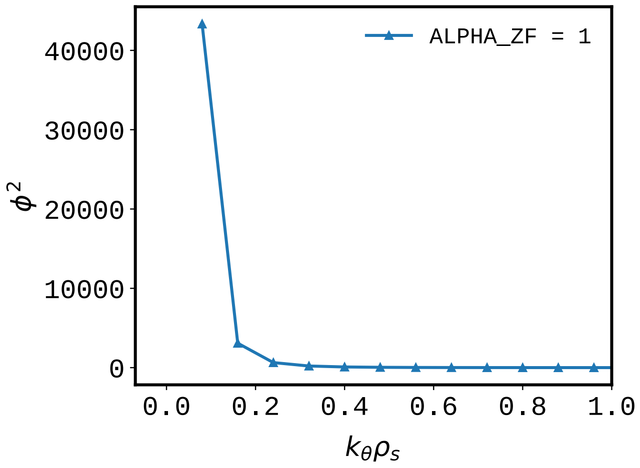
TGLF inputs

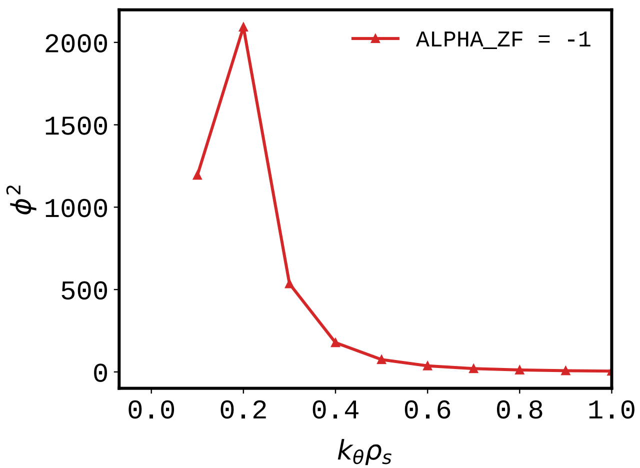
Exclusion of low k_y modes in saturation rule for $\gamma/k_{y_{MAX}}$



- The ion-scale peak of γ/k_y is found at the lowest k_y in the spectrum, leading to a notable increase in fluxes

Exclusion of low k_y modes in saturation rule for $\gamma/k_{y_{MAX}}$



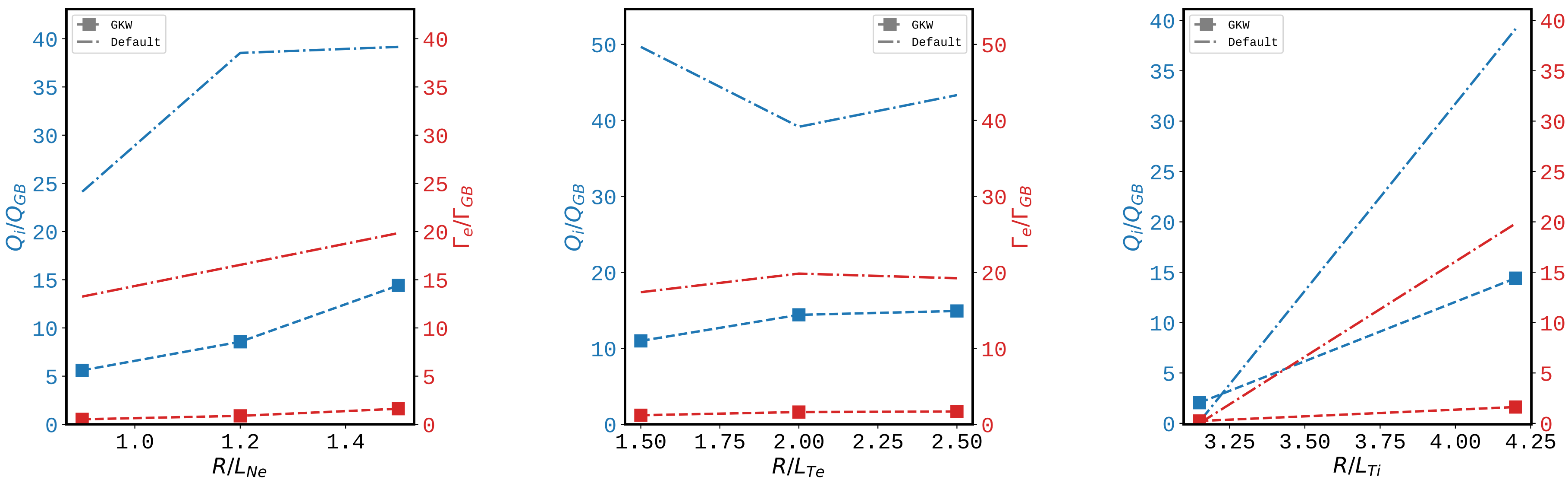


- **The ion-scale peak of γ/k_y is found at the lowest k_y in the spectrum, leading to a notable increase in fluxes**
- **Ignoring very low k_y for the peak in γ/k_y**
- **This feature can be activated by setting ALPHA_ZF = -1**

TGLFsat2 QL fluxes vs GKW Non-linear fluxes

QL fluxes using the default settings of TGLF

Filter = 2; Alpha_zf = 1; Kygrid_model = 1; Nky = 19; Nbasis_max = 6

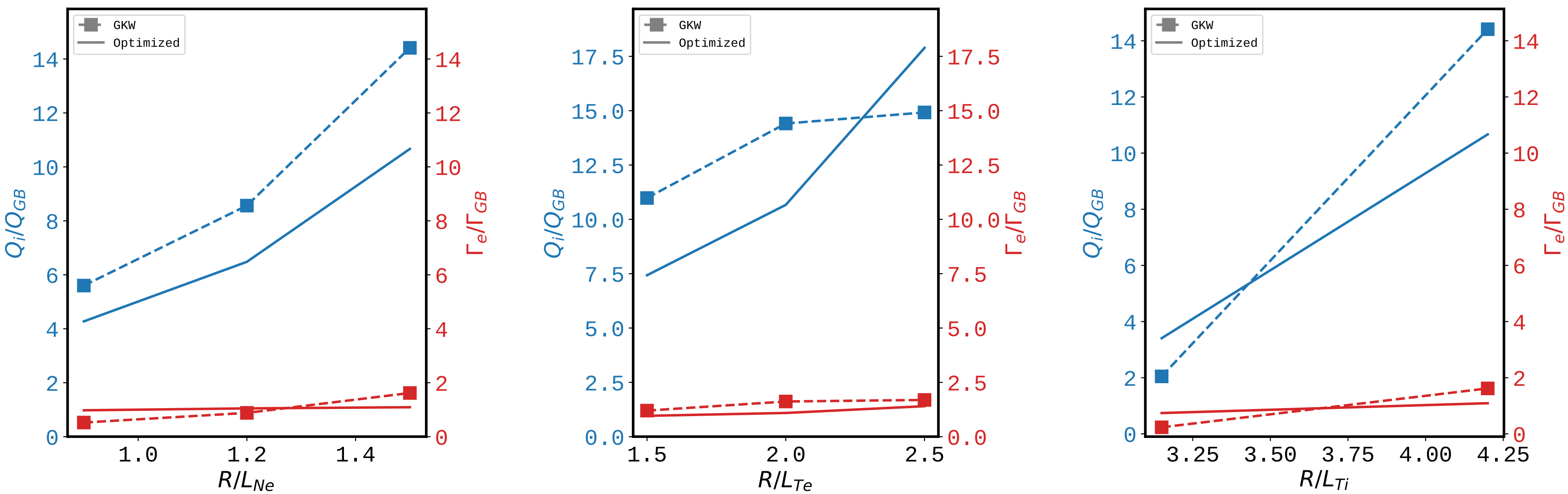


The fluxes obtained do not align with those obtained with GKW

TGLFsat2 QL fluxes vs GKW Non-linear fluxes

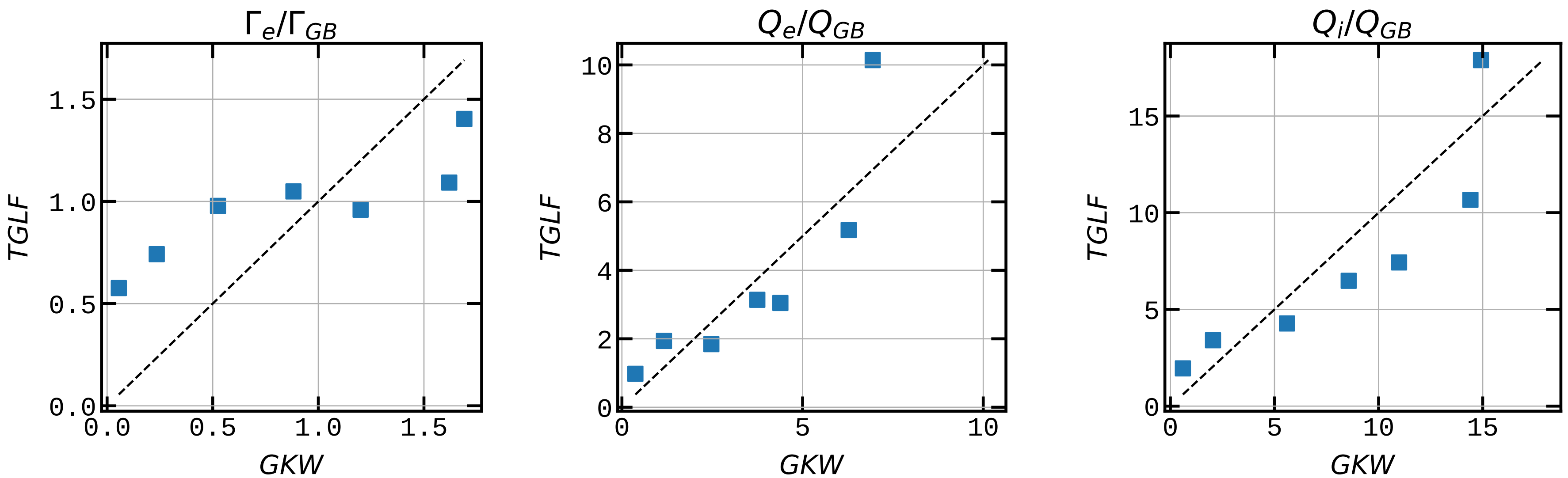
QL fluxes using optimized settings of TGLF for KBMs

- Not filtering high frequency modes (Filter = 0)
- Filtering low k_y unphysical modes
- Peak of γ/k_y not at lowest k_y (Alpha_zf = -1)
- Detailed k_y grid (NKY = 30, KY= 1.5, Kygrid_model = 0)



TGLFsat2 QL fluxes vs GKW Non-linear fluxes

QL fluxes using optimized settings of TGLF for KBMs



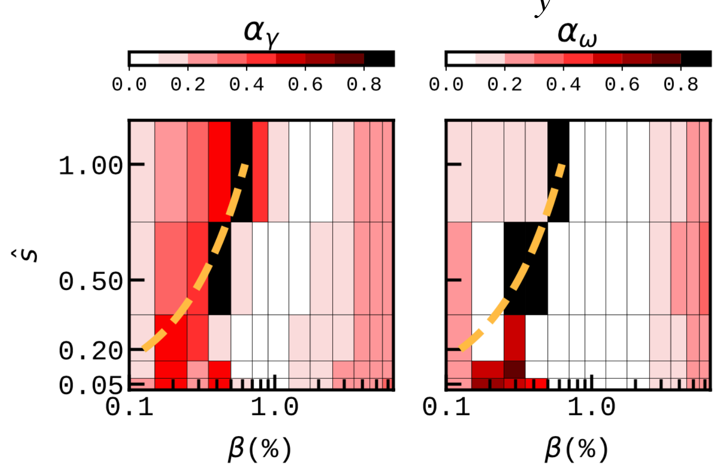
$$R/L_{N_e} : \{0.9; 1.2; 1.5\} \quad , \quad R/L_{T_e} : \{1.5; 2.0; 2.5\} \quad , \quad R/L_{T_i} : \{3.15; 4.2\}$$

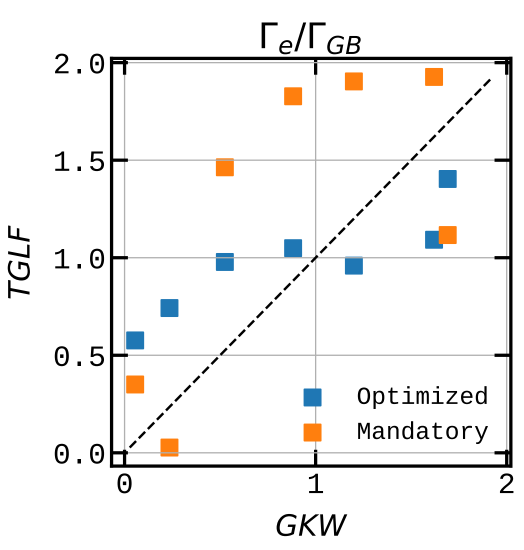
Quasilinear approximation is valid for KBMs as long as the linear response is accurate

Conclusion

- **TGLF generally models KBMs well, with exceptions in specific regions:**
  - **At very low magnetic shear, specially at low k_y**
  - **At the ITG-KBM transition**
- **Specific input settings are mandatory for accurate QL flux predictions of KBMs:**
  - **To preserve KBMs : Filter = 0**
  - **To avoid spike in fluxes : Alpha_zf = -1**
- **TGLF have shown to be able to predict correctly GKW Non Linear fluxes in KBMs regime as long as the linear response is accurate**

Waltz STD case at $k_y = 0.4$





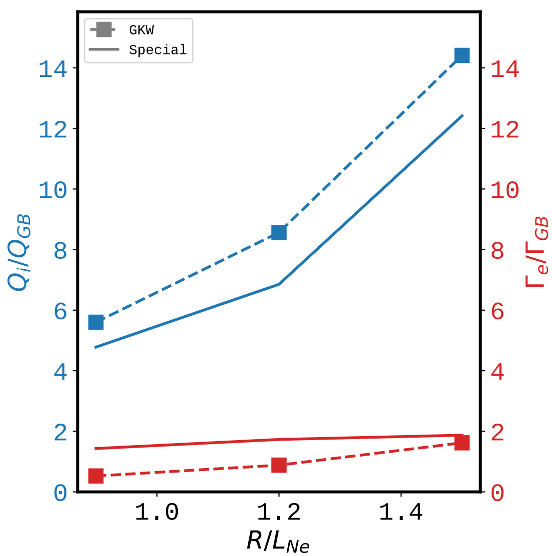
Thank you for your attention

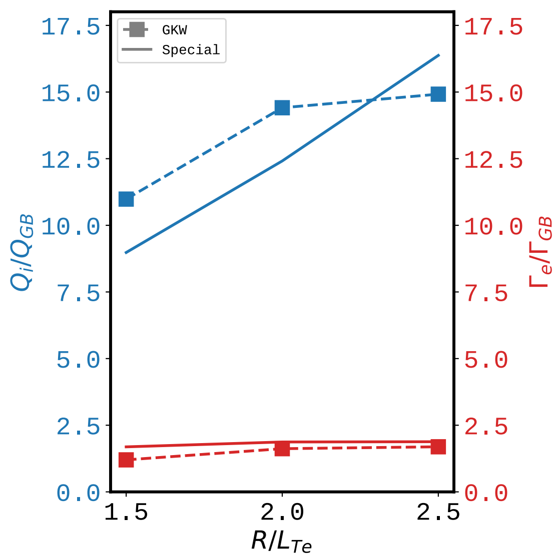
Aix*Marseille université
Socialement engagée

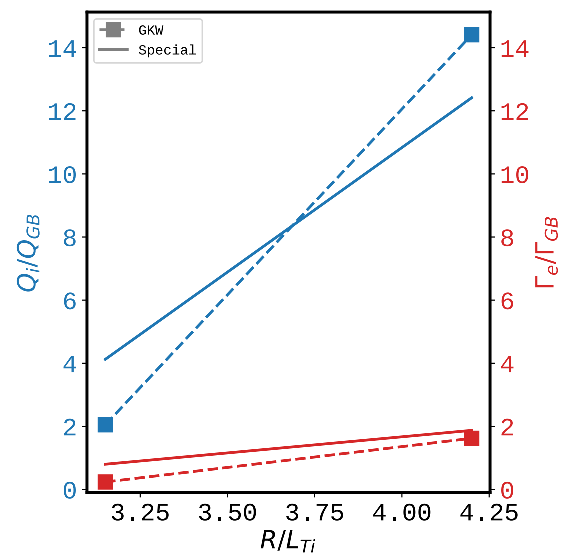
TGLFsat2 QL fluxes vs GKW Non-linear fluxes

- **Not filtering high frequency modes (Filter = 0)**

- **Peak of γ/k_y not at lowest k_y (Alpha_zf = -1)**
- **Detailed k_y grid (NKY = 30, KY= 1.5, Kygrid_model = 0)**



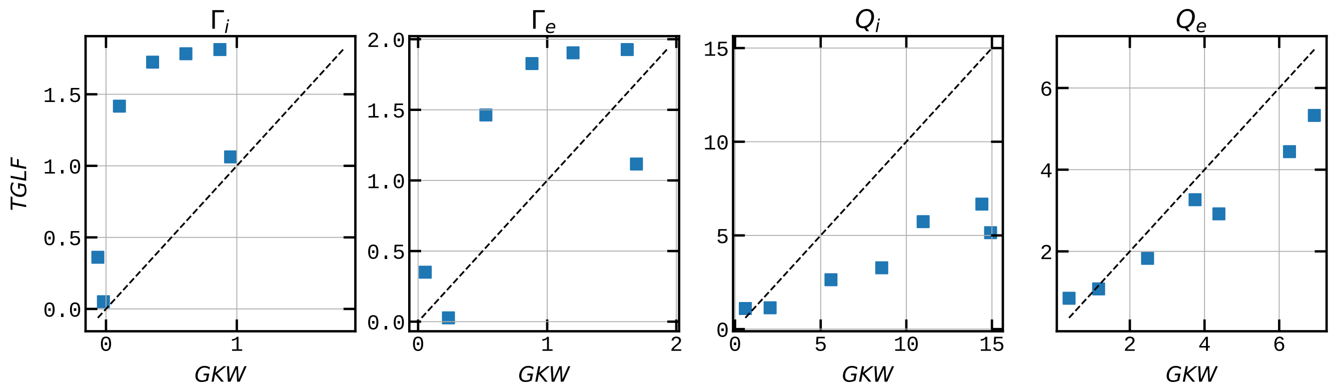


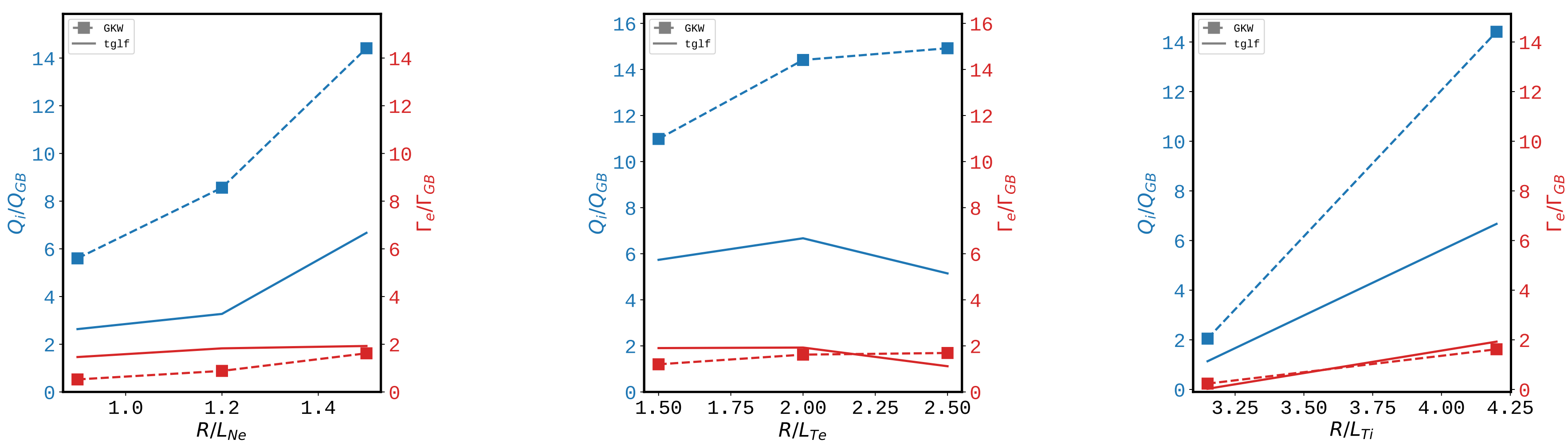


Aix Marseille université
Socialement engagée

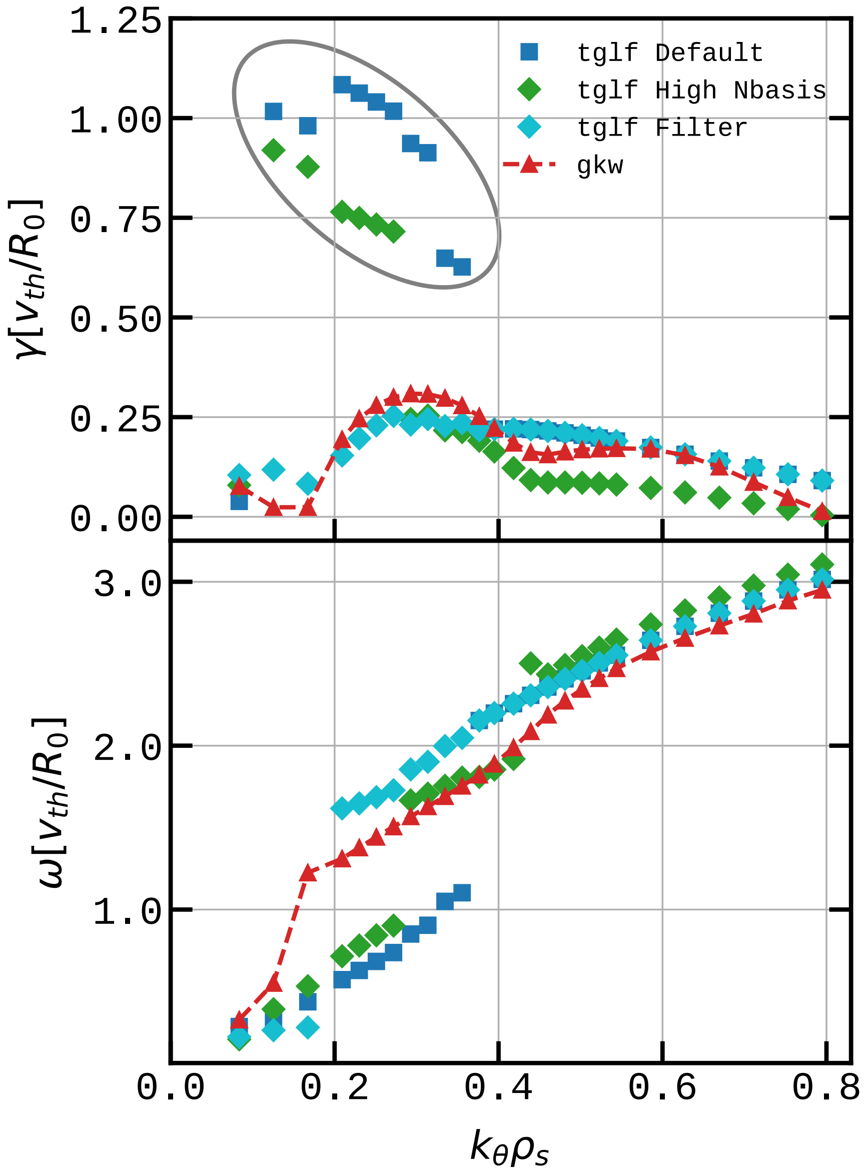
TGLFsat2 QL fluxes vs GKW Non-linear fluxes

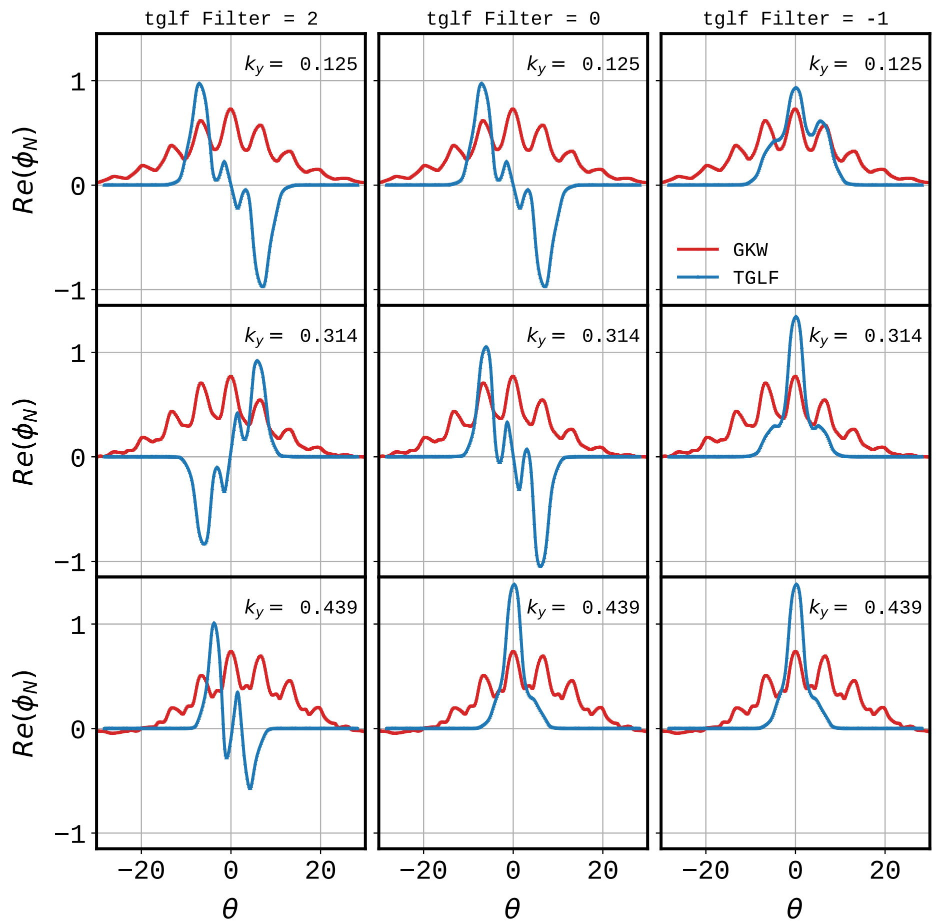
Alpha_zf=-1. Filter = 0. KYgrid_model= 1





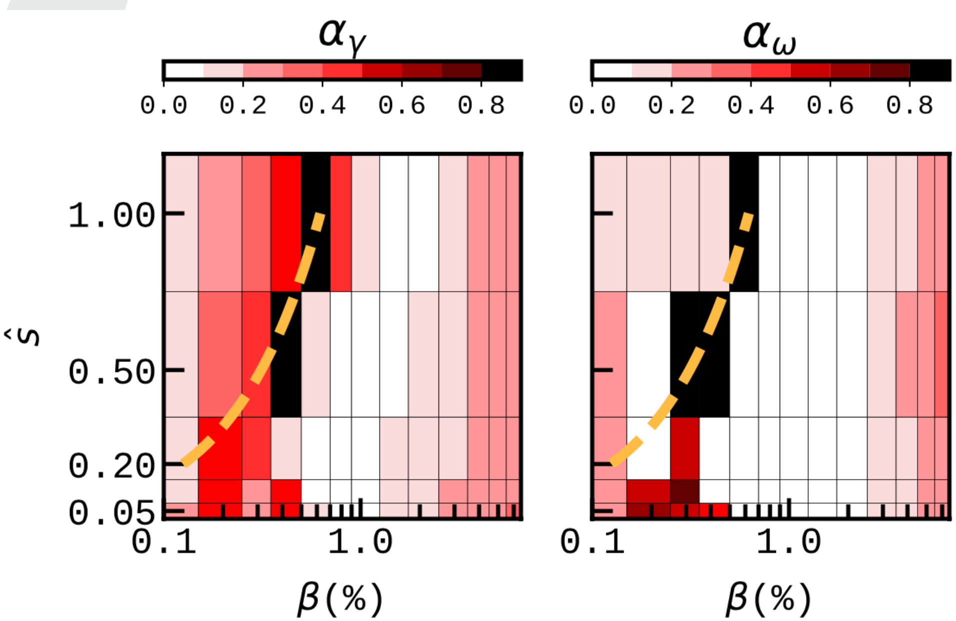
Aix*Marseille université
Socialement engagée



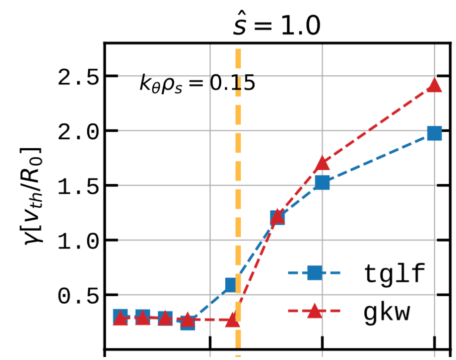


Benchmarking Linear Response: Theoretical Waltz STD Case

q	$\hat{s}$	$\varepsilon = r/R$	R/L_n	$R/L_{Ti} = R/L_{Te}$	T_i/T_e
2	1	0.16	3	9	1.0



$$\alpha_{\mathbf{X}} = \frac{|\mathbf{X}^{GKW} - \mathbf{X}^{TGLF}|}{|\mathbf{X}^{GKW}|}$$



Overall good agreement both in ITG and KBM region with the same tglf settings