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Panel Discussion of Gravity Waves

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Saturation Theories

1. "Linear instability" theory

- Dewan + Good ('86), Smith et al. ('87)

"Saturated cascade"

- Dewan ('91)

positives:

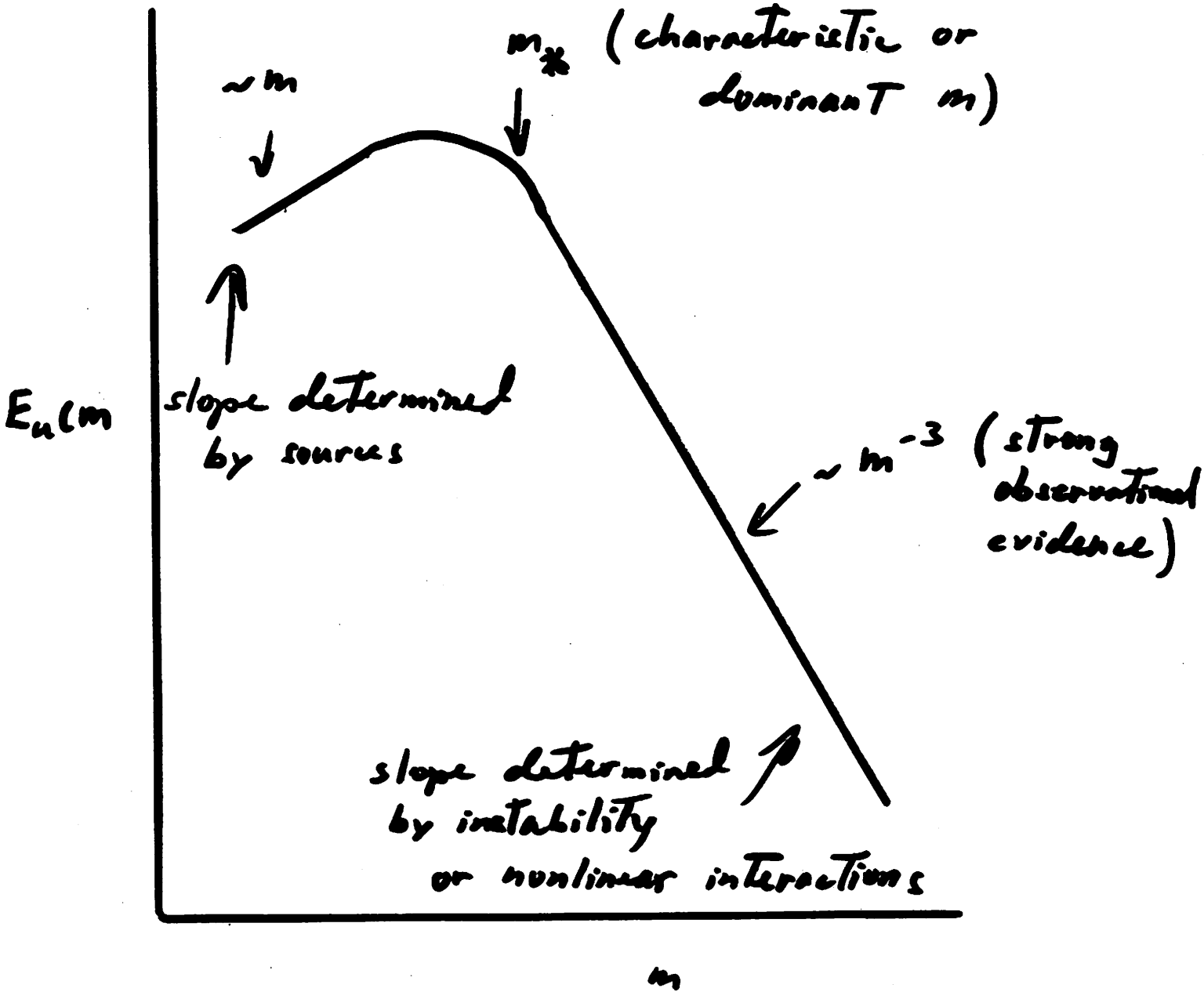
- clear observ. evidence for instab. constraints on wave amps. (Hodges, '67)
- accounts for N^2 variations, scale changes, decreasing m_*, $E(z)$ vars. naturally

negatives:

- ampl. constraints ad hoc
- packet bandwidth arbitrary
- does <u>not</u> include wave-wave int. effects

<u>specific failing:</u>

- stratospheric scaling of ampl. with N^2 does not account for wave filtering by shear and N^2 reductions


m_* (characteristic or dominant m)
$\sim m$
$E_u(m$
slope determined by sources
$\sim m^{-3}$ (strong observational evidence)
slope determined by instability or nonlinear interactions
m

2. Doppler spread Theory

- Hines ('91, ...)

positives:

- conceptually simple + appealing
- has led to GW parameterization with some nice attributes

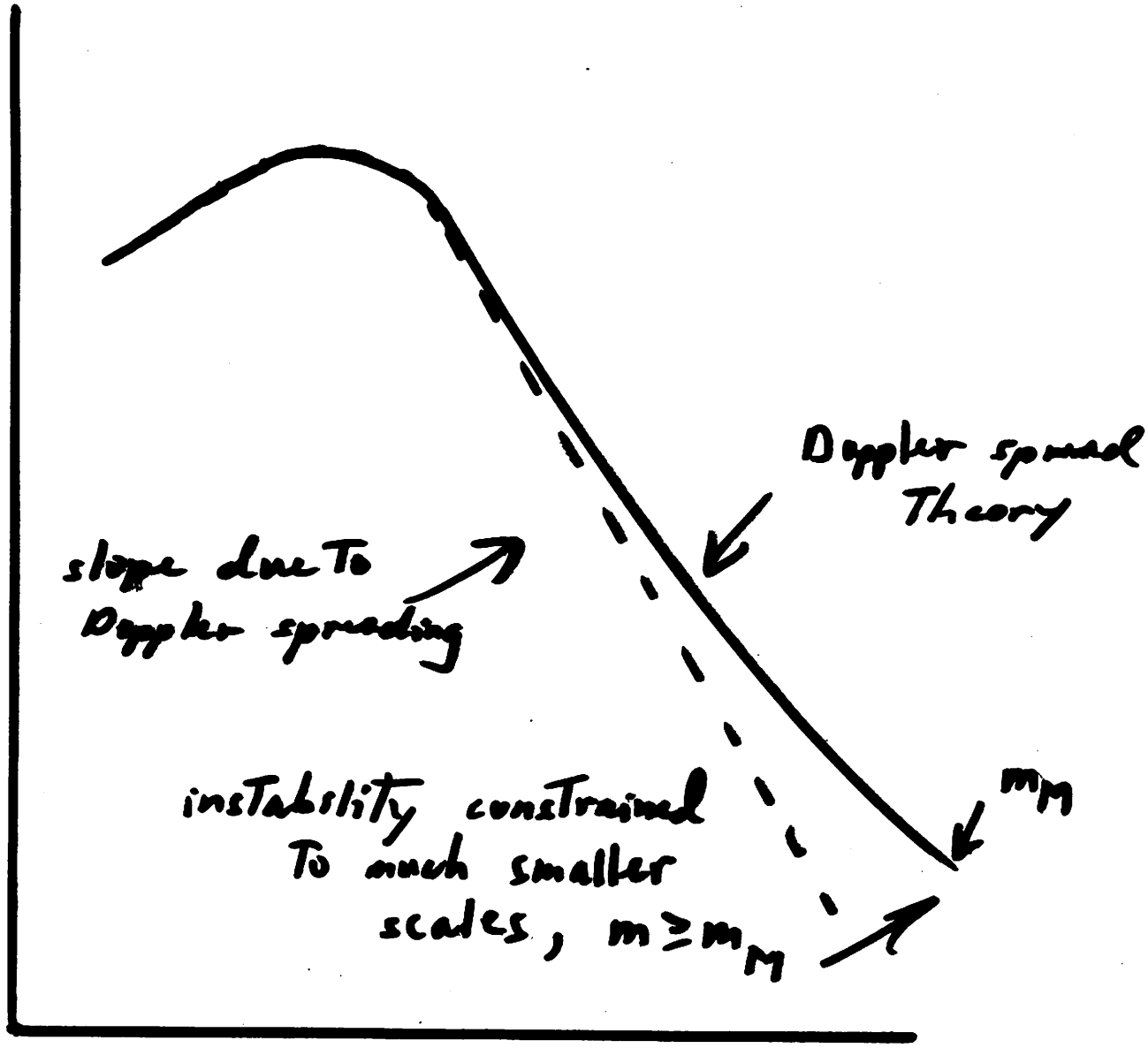
negatives:

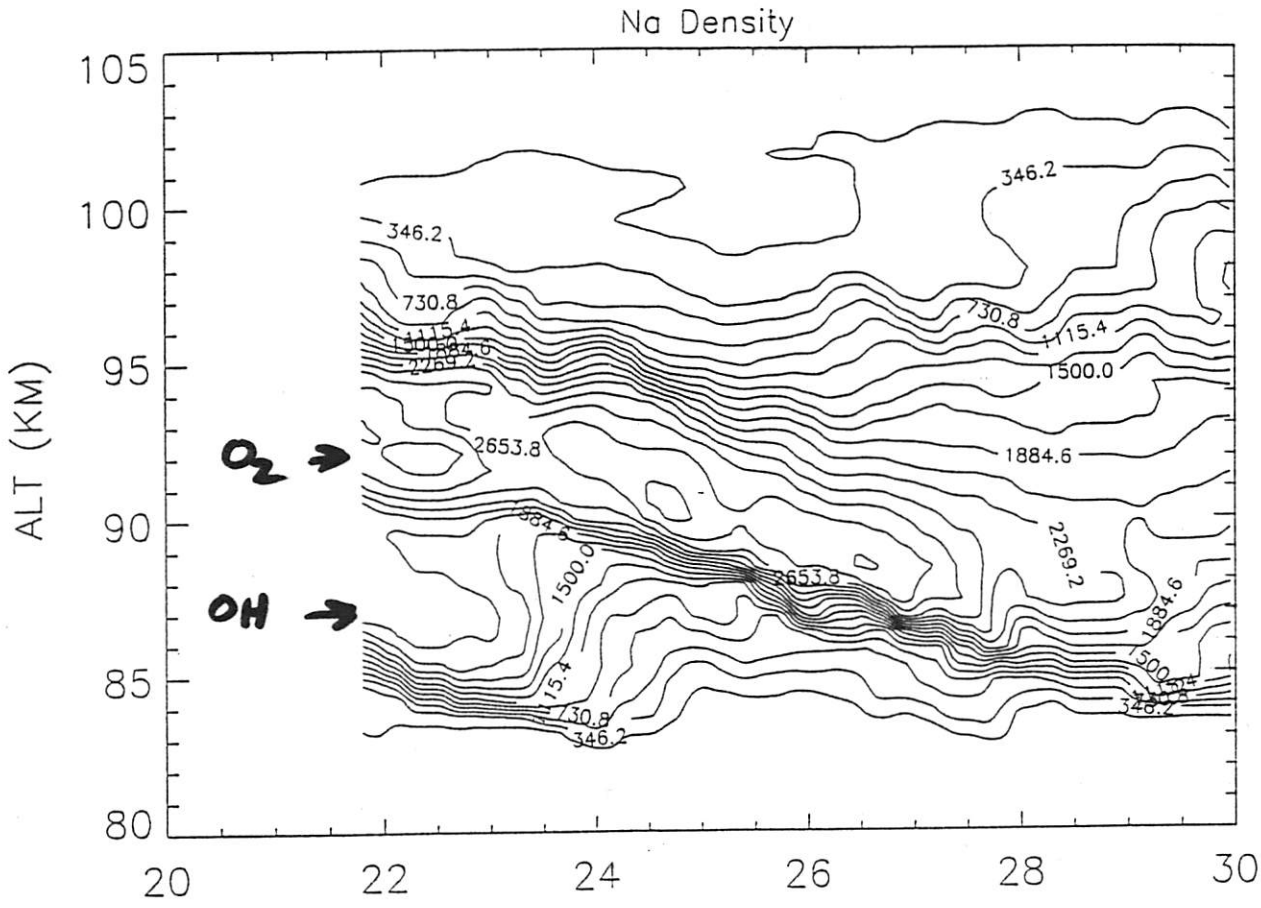
- fails to account for observed "Tail" spectrum, $\sim m^{-2.7}$ or shallower
- fails to account for wave dissipation at observed scales ($m \ll m_M$)

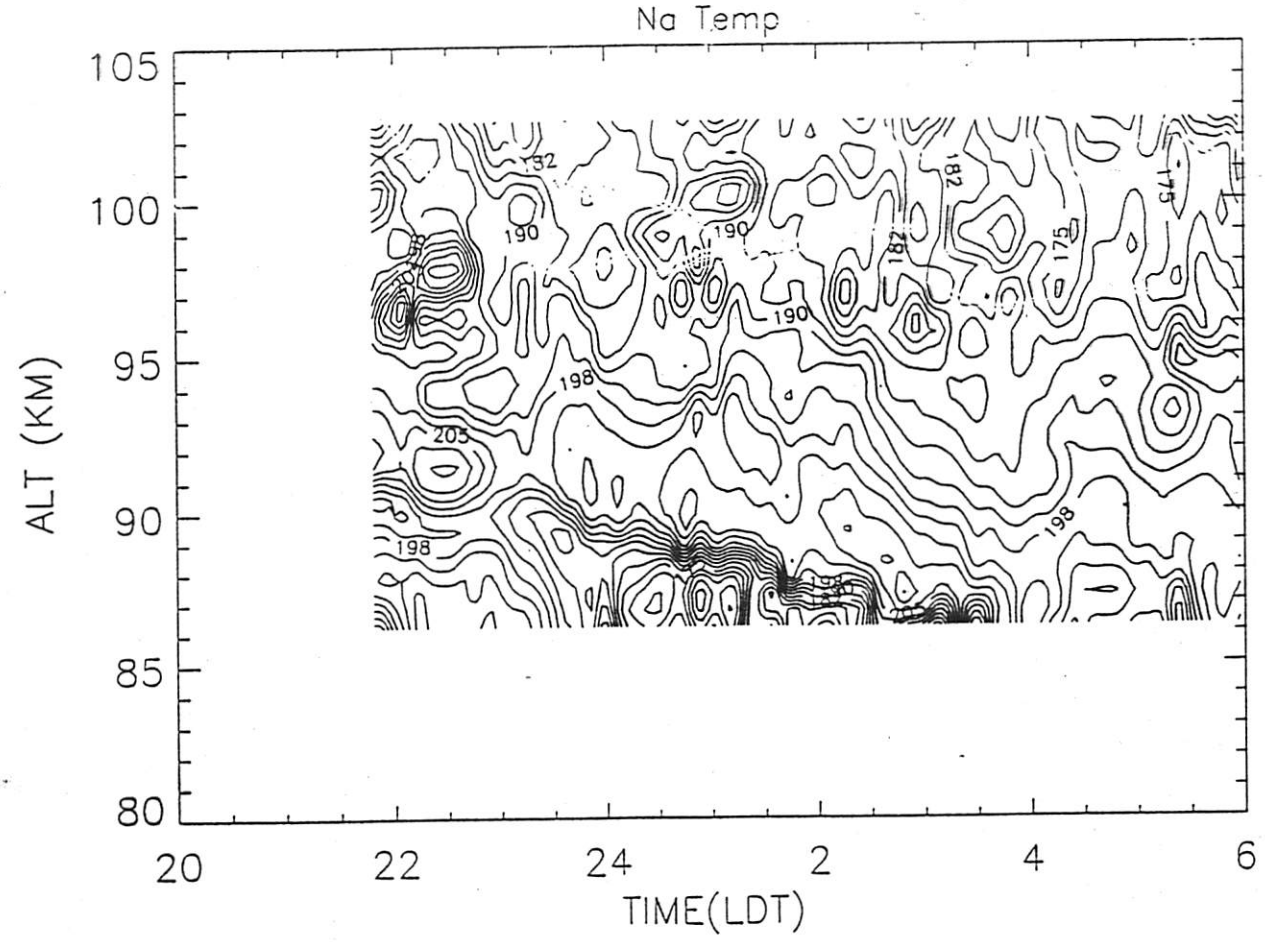
major failing:

- primary approximation of DS Theory is <u>not</u> valid
- fails consistency check with ray theory (Eckermann, '97, JAS, in press)

Doppler spread spectrum

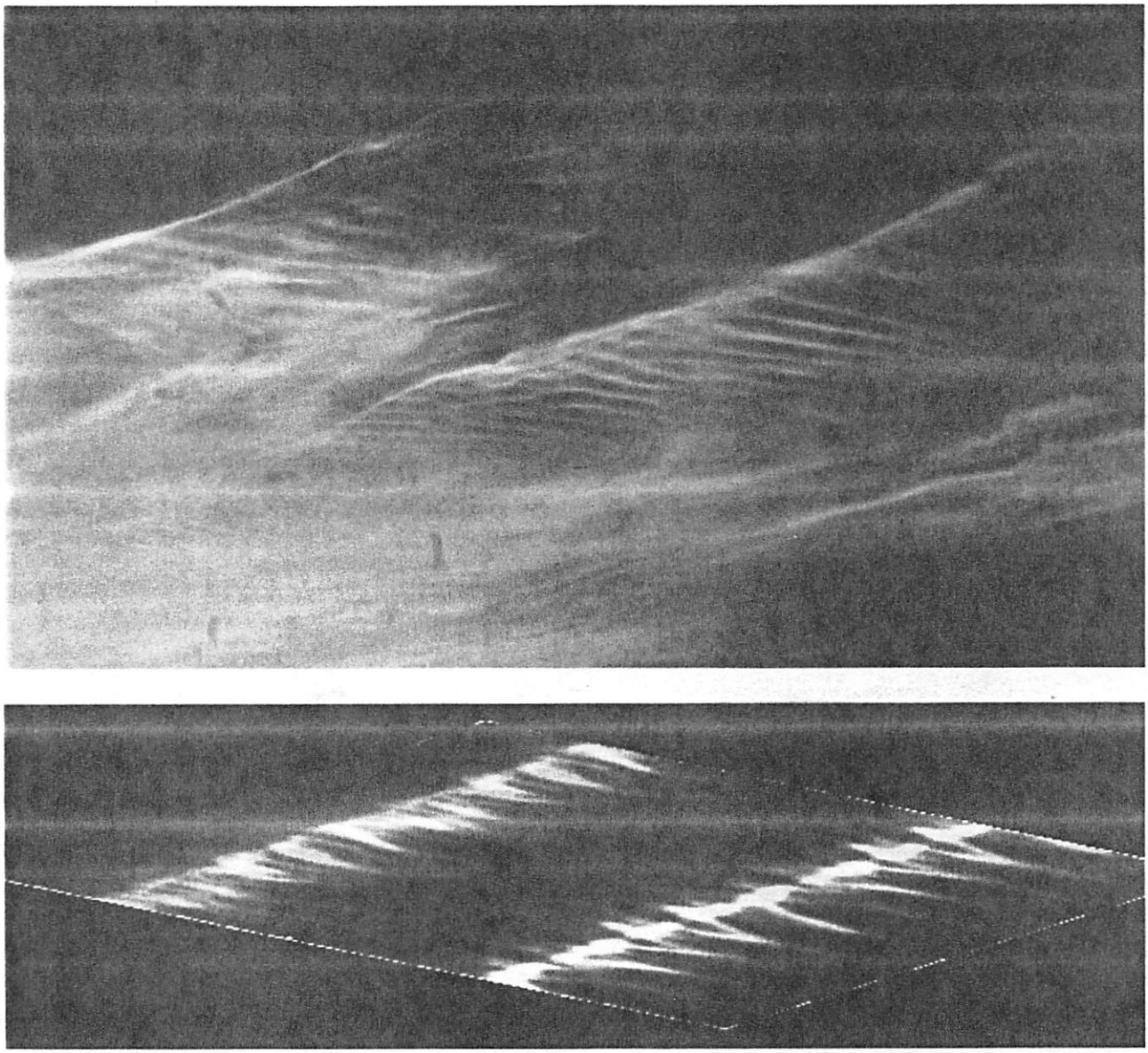






CORN Hecht et. al. ('97)

Geophysical Research Letters



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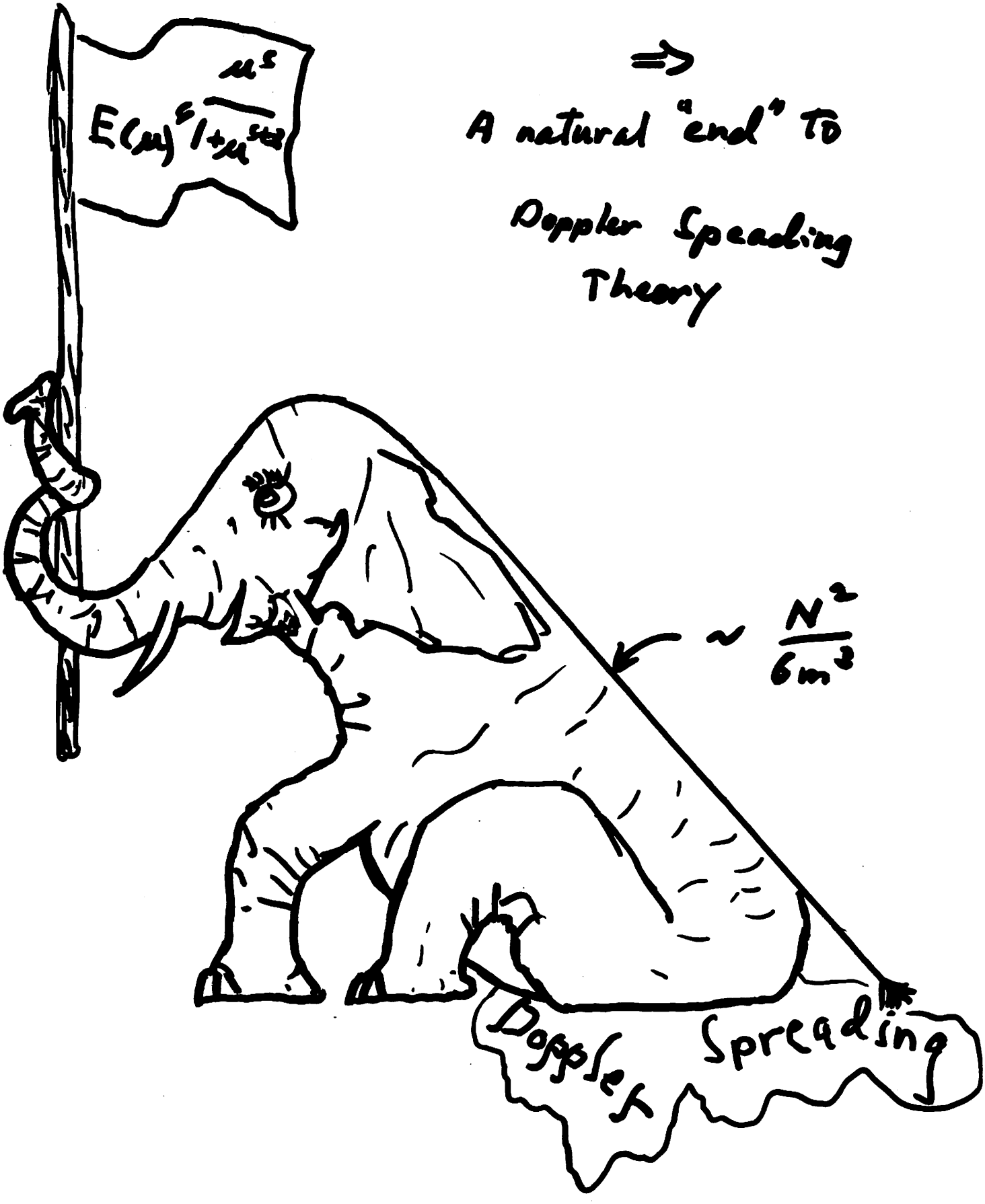
The "weight" of evidence

$\Rightarrow$

A natural "end" TO

Doppler Spreading Theory



3. Nonlinear diffusion + variants

- Weinstock ('90), Zhu ('94), Medvedev + Klaassen ('95)
- Gardner ('94) - "diffusive filtering"

positives:

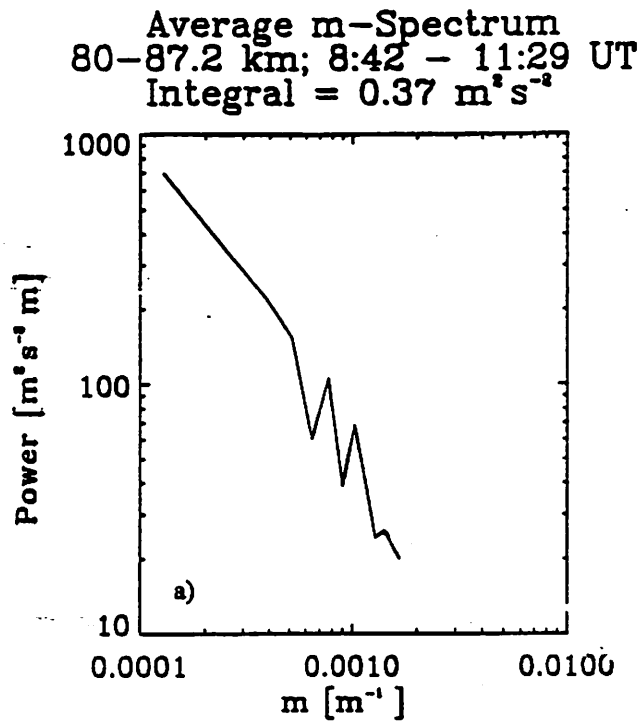
- account for partial advective NL's
- predicts correct spectral shapes w/in amplitude factor for $E_k(m)$

negatives:

- "NL" Theories neglect certain NL int's.
- "diffusive filtering" neglects wave-wave int's
- damping mechanism ad hoc, speculative

<u>major failing:</u>

- Testable + <u>incorrect</u> predictions for $E_w(m) \sim m^1$ for $p = 2$ (ω^{-p}) by diffusive filtering theory



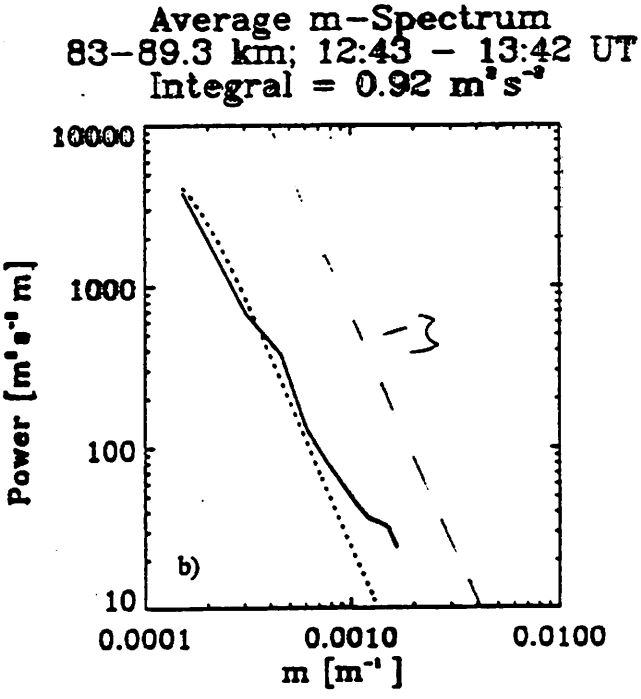


Figure 5. Vertical wavenumber spectra for altitudes from 80 to 87.2 km averaged (a) from 0842 to 1129 UT and from (b) 83 to 89.3 km averaged from 1243 – 1342 UT. The spectra are representative of ducted and propagating wave environments, respectively. Note that the integrated variances are much less than those obtained from the time series in each case because of the mean and linear trend removal. The canonical vertical wavenumber spectrum having the same variance is shown with a dashed line for reference in Figure 5b.

Fritts + Hoppe ('95, JGR)

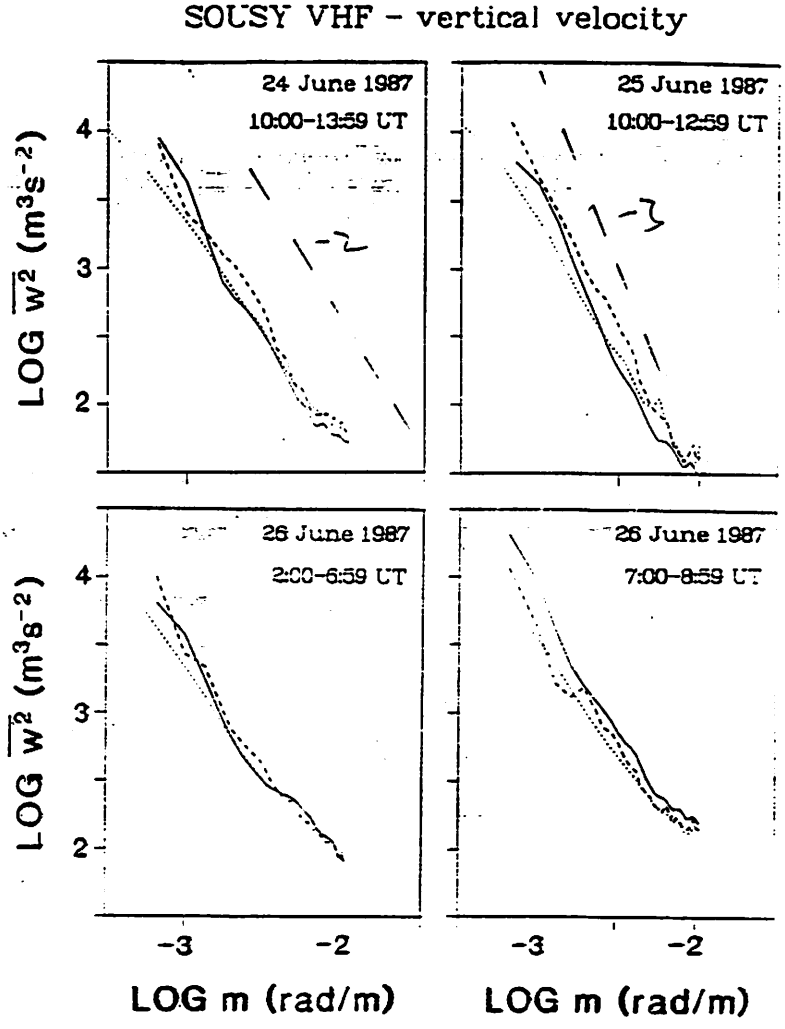


Fig. 11. SOUSY vertical wavenumber spectra averaged for four periods of 2- to 5-h duration using an FFT with a cos² taper (——), an FFT with a box window and linear ramps (— — —) and MEM with no tapering (···). Slopes at lower wavenumbers approach −3. At higher wavenumbers, the spectra are likely influenced by measurement errors and proximity to L_B.

Fritts et al. ('90, JATP)

Summary:

- **All** present Theories are

  - *ill-posed*, *incomplete*, or *incorrect* in significant ways

- Yet all Theories also contain aspects which have helped to illuminate the physical processes we must describe more completely

- Theoretical difficulties ⇒

  The full NL problem including
  - spectral (wave-wave) interactions
  - local wavefield instabilities

  is *analytically intractable*

⇒ we will likely need to rely on *numerical methods* to address the interplay between these processes more completely.