On the Incidence and Kinematics of Strong Mg II Absorbers

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But what are these systems?

Systems of interest are big!

\[ W_r > 1.0 \text{ Å} \]
Local-Universe Hints

Locally, two very different kinds of systems are known to harbor Mg II absorption in the $0.5 \, \text{Å} < W_r < 5.0 \, \text{Å}$ range:

- Post-starburst galaxies with SN-driven 'bubbles' being pushed into IGM
- Large, quiescent galaxies with cold clumps of gas galling through halo

BUT: Does this extend to high-z? How do we find out?
High-z Clue 1: $dN/dz$

- Redshift Path Density of Absorbers
- Can we relate observed $dN/dz$ to known objects?

High-z Clue 2: Morphology

- At high redshift, can we relate observed kinematic structure of systems to observations of the local universe/theoretical results of system structure?
A Closer Look: Supperbubbles

e.g., Bond, Churchill, Charlton, & Vogt (2001)

- Rapidly expanding ionized bubbles of gas, enriched and powered by correlated supernovae explosions of the stars on the high end of the SB region's mass-function. Another possibility: energetic mergers
- Expected velocities of $\sim 100-1000$ km/s
- Cartoon Picture:
(simple) SB Mg II Profile

Central, hot, rarefied region

Outer Shells

Normalized QSO light

Note: 'clumpiness' in shell may lead to more complicated spectra
...And: Quiescent Galaxies

e.g., Mo & Miralda-Escude (1996)

• Gaseous galactic halos in two phase structure:
  Shock heated hot phase
  Photoionized phase moving through halo

• Primarily restricted to the halos of massive galaxies because gas can only cool where dense enough to radiate efficiently

• Typical impact parameters of $<30 \, \text{h}^{-1} \, \text{Mpc}$

• 'Slow evolution' of $\text{d}N/\text{d}z$ with redshift (related directly to the density of the Universe)
ONE KEY DIFFERENCE:

Evolution of the redshift path density (dN/dz) is QUITE dependent on underlying population.

\[ \frac{dN}{dz} \propto (1+z)^Y \]

Quiescent evolution (goes as inv. scale factor): \( Y \sim 1 \)

Merger evolution (density dependent): \( Y \sim 3 - 4 \)

OKAY, SO LET'S LOOK AT SOME DATA!
Data 1: SDSS-DR2

- 31461 Quasars with r'<20.5, unbiased
- R ~ 2000
- Wavelength Coverage: 3800-9200 Å
  \(0.35 < z < 2.3\) For Mg II
- Automated search:
  - Continuum Fit
  - Candidate Absorption Lines Identified
  - Line Lists Searched for Mg II Spacing
  - Candidate Systems Culled 'by-eye'
  - Monte-Carlo Simulations to Test for Completeness
  - > 95% Complete

- Resulting in: \(4012 W_r(2796) > 1.0\) Å Systems
  \(2195 W_r > 1.4\) Å Systems
  \(1134 W_r > 1.8\) Å Systems
Data 2: ESI/HIRES Spectra

- 51 HIRES QSO Spectra
- 41 ESI QSO Spectra
- Search Technique:
  - Continuum Fit
  - Spectra Searched 'by-eye'

- Resulting in $22 \, W_r > 1.0 \, \text{Å}$ Systems
Now for Morphology:
...and $dN/dz$:

$Y \sim 1.5 - 2.0$
Implications

- dN/dz:
  - Power-law fit:
    - Ave. value consistent with SBGs, BUT:
    - Y < 2: Hard to incorporate merger scenario into observed evolution – too shallow for mergers to be the dominate population of Mg II absorbers
    - Still, a bit high to be just big galaxies...

- Morphology:
  - In general, morphology satisfies criteria set down by Bond et al. for supperbubbles
  - PROBLEM: High/Low ionization state metals seems to share morphological state! This doesn't jive with theory just yet....
Work to Come

• Two-point correlation function: mass?

• AO imaging of low-z systems

• IR observations (GNIRS/Gemini South) to extend dN/dz to higher redshifts

• Dust reddening? Gravitational lensing?