and f_{low} of volumes occupied by this material, such that $f_{hi} + f_{low} = 1$; furthermore they studied the possibility of having this bimodal medium at different densities. The range of temperatures used was $6500 \leq T_e \leq 35000$, and the range of densities $10^4 \leq N_e \leq 10^6$.

From a comparison with a sample of PNe we found the following results: (A) O^{++}/H^+ derived from recombination lines is × 2.7 that form forbidden λ5007. (B) $(C^{++}/O^{++})_{rec}$ and $(C^{++}/O^{++})_{UV}$ agree. The mean value of $\langle X \rangle = 0.88$. (C) In most PNe the observed line strength ratios require a wide distribution of temperature and densities. However there might be unexplained temperature fluctuations of very dense clumps ($n \leq 10^{5.6}$cm^{-3}) ionized to O^{++} and contributing $\geq 10\%$ of the emission measure from O^{++}

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MODELS OF COMPACT H II REGIONS

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Compact H II regions are thought to be produced by recently formed O and early B type stars still embedded in their parent cloud. They are usually found in groups and are characterized by electron densities in the range $\sim 10^3 - 10^4$ cm^{-3}, sizes 0.05 – 0.3 pc, and emission measures $\sim 10^7$ pc cm^{-6} (e.g., Wood & Churchwell 1989; Garay et al. 1993; Kurtz, Churchwell, & Wood 1994). The overpressure of the H II regions makes them expand into the natal cloud. Using the classical model of the evolution of H II regions (e.g., Spitzer 1978), a region of ionized gas excited by an O7 star, born in a medium with a constant ambient density of 10^5 cm^{-3}, would have expanded to a radius of 0.1 pc after only $\sim 10^4$ years. Then, the small sizes of the compact H II regions would imply that they are very young objects, with lifetimes $\sim 10^4$ years. In an ambient medium with a density gradient the evolution of the H II regions can be even faster (e.g., Franco, Tenorio-Tagle, & Bodenheimer 1989, 1990). Wood & Churchwell (1989) found, however, that there are too many compact and ultracompact (diameters < 0.05 pc) H II regions to be consistent with their short dynamical ages. They concluded that the expansion of these H II regions is inhibited by some mechanism, so that their small sizes do not necessarily indicate that they are extremely young. Several suggestions have been made to explain the large discrepancy between the observed number of compact and UCHII regions and the number expected from the formation rate of massive stars and the time they spend in this compact phase (cf., Churchwell 1990).

In this review we discuss the current models proposed to lengthen this compact phase. These models involve bow shocks (Van Buren et al. 1990), the photoevaporation of disks around massive stars (Hollenbach et al. 1994), high density molecular cores (DePree, Rodríguez, & Goss 1995), and mass loaded stellar winds (e.g., Lizano et al. 1996; Dyson, Williams, & Redman 1996).

Finally, we note that the observed excess number of compact and ultracompact H II regions has stimulated theoretical research on physical mechanisms that could lengthen this compact phase. Probably all or a combination of these mechanisms occur in nature. The observational challenge is now to prove or discard the proposed models.

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NOVAE AND BAL QSO'S: THE ALUMINUM TEST

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Broad absorption lines (BALs) caused by rapidly ($\lesssim$ 30 000 km s^{-1}) outflowing gas are seen in the spectra of ~ 10% of radio quiet QSOs (Weymann et al. 1991). Analysis of the derived column densities has led to reported abundances of C, N, O, Si, and sometimes other elements, that are 1 to 2 orders of magnitude greater than solar (Turnshek et al. 1996, and references therein). An especially high abundance of phosphorus, $P/C \approx 65\ (P/C)_\odot$, was reported by Junkkarinen et al. (1995). Shields (1996) proposed that the BAL gas largely consists of debris of nova explosions occurring in the inner few light years of the QSO nucleus. This is motivated by high phosphorus abundances in the ejecta of model novae (Politano et al. 1995) and by the resemblance of C, N, O, and Si abundances in observed "neon nova" shells to those in BAL QSOs. The needed rate of novae could occur in a nuclear star cluster of mass $\sim 10^8\ M_\odot$, in which single white dwarfs accrete hydrogen by means of repeated orbital passages through an accretion disk around a supermassive black hole.

Nova models predict enhanced abundances of odd numbered elements, relative to neighboring even numbered elements; and high Al is observed in nova debris (Andreä et al. 1994). Al III λ1857 is seen both in BAL and broad emission-line (BEL) spectra. This offers a potential test of novae as a source of BAL gas and as a contribution to the BEL gas. Analysis of UM 232, a BAL QSO for which Barlow et al. (1989) observed Si IV and Al III absorption with favorable parameters for determining Al/Si, gives N(Al)/N(Si) ≈ 0.9, roughly ten times the solar value. QSO observations contain other hints of high Al in the BAL and BEL gas, although major systematic uncertainties exist. This work is described in greater detail by Shields (1997).

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GAMMA-RAY BURSTS

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After almost 30 years of study, gamma-ray bursts remain unexplained. They occur about once per day, typically last from under a second to hundreds of seconds, and emit most of their energy in the 100 keV to 1 MeV energy range. A wide range of temporal behavior is seen, from single smooth pulses to complex structures with dozens of peaks. The Burst and Transient Source Experiment (BATSE) has observed over 1800 bursts in six years of operation. BATSE discovered that the burst directions are distributed isotropically, and that the intensity distribution exhibits a deficit of weak bursts relative to the $-3/2$ power law expected for a homogeneous distribution of sources. These results are not compatible with a galactic disk source distribution, but are consistent with a cosmological interpretation with the faintest sources at redshifts of $z \sim 1$. Alternatively, an extended galactic halo populated with high-velocity neutron stars has been suggested as the source of the bursts. The main difficulty with this model is that a number of parameters must be fine-tuned to reproduce the isotropy and inhomogeneity. In particular, the very low upper limits to any anisotropy are problematic for any galactic model. Recently, X-ray and optical counterparts have been identified for a few bursts, leading to some optimism for significant progress in finally unraveling the gamma-ray burst mystery.

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MILLIMETER-WAVE OBSERVATIONS OF GAMMA-RAY BURSTERS

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The Satellite per Astronomia X (*BeppoSAX*) is successfully producing small error boxes to gamma-ray bursts, permitting rapid follow-up multiwavelength searches for fading and quiescent counterparts. For GRB 970228, this led to the discovery of the first fading X-ray and optical counterpart to a burster. In our talk, we presented our observations approximately one week after GRB 970228 and one month after GRB 970111 using the Berkeley-Illinois-Maryland Association array (BIMA) at 3.5 mm. Although we did not detect any fading sources, we showed that future searches in the millimeter region are promising, based on completely different models. Provided the millimeter observation is done sufficiently soon after the burst, the millimeter flux can be significantly brighter than at the longer radio wavelengths. Full details will appear elsewhere (Smith, I. A., Gruendl, R. A., Liang, E. P., & Lo, K. Y. 1997, ApJ Letters, in press).

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