Specified Intersections

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Let M be a subset of {0, .., n} and F be a family of subsets of an n element set such that the size of A intersection B is in M for every A, B in F. Suppose that l is the maximum number of consecutive integers contained in M and n is sufficiently large. Then we prove that
|F| < min {1.622^n 100^l, 2^{n/2+l log^2 n}}.
The first bound complements the previous bound of roughly (1.99)^n due to Frankl and the second author which applies even when M={0, 1,.., n} - {n/4}. For small l, the second bound above becomes better than the first bound. In this case, it yields 2^{n/2+o(n)} and this can be viewed as a generalization (in an asymptotic sense) of the famous Eventown theorem of Berlekamp.
Our second result complements the result of Frankl-Rodl in a different direction. Fix eps>0 and eps n < t < n/5 and let M={0, 1, .., n)-(t, t+n^{0.525}).
Then, in the notation above, we prove that for n sufficiently large,
|F| < n{n \choose (n+t)/2}.
This is essentially sharp aside from the multiplicative factor of n. The short proof uses the Frankl-Wilson theorem and results about the distribution of prime numbers.

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