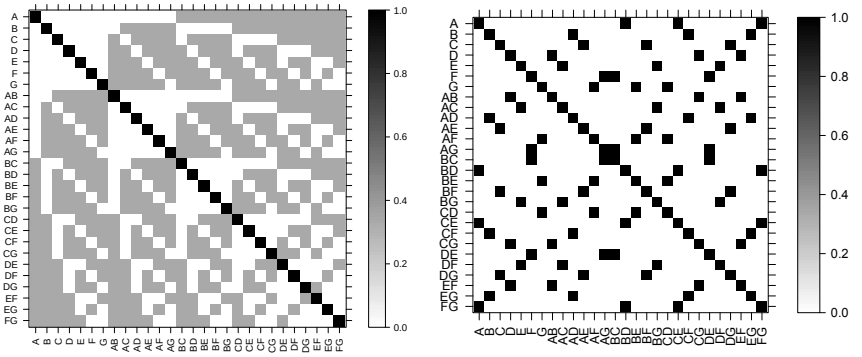
projection property. The hidden projection property allows some interactions to be estimated even though the design is resolution III. This can be illustrated graphically as shown in Figure 6.13. The graph on the left side of the figure shows the color map of correlations computed from the design matrix for the Plackett-Burman design. The color map on the right side of the figure was computed from a resolution III 2^{7-4} fractional factorial.

Figure 6.13 *Color Map Comparison of Confounding between PB and FF Designs*



(a) Plackett-Burman Design

(b) 2^{7-4}_{III} design

In these graphs we can see that each main effect is completely correlated or confounded with exactly three two-factor interactions for the resolution III fractional factorial design, but for the Plackett-Burman design, each main effect is partially confounded (correlation coefficient ±0.333) with 15 two-factor interactions. Since the correlations between main effects and interactions are not ±1 for the Plackett-Burman design, some interactions can be included in the model as long as the total number of terms in the model is less than the number of runs in the design. The color maps were created with the `colormap` function from the `daewr` package that is illustrated in the R code for this chapter on web page for the book.

For Plackett-Burman designs where only a subset of the factors appear to be important, Wang and Wu have shown that it is likely that a model can be fit to the data by regression, which includes the important main effects and two-factor interactions involving the important main effects. When interaction terms are included in the model, the design becomes non-orthogonal and effects must be estimated by regression, but Wang and Wu have shown that the D-efficiency remains quite high. Usually some type of regression subset selection procedure is used in order to identify the most appropriate model.

For the data in Table 6.11, the R code on the next page uses the `regsubsets` function in the package `leaps` (Lumley, 2009) to perform an all-subsets regression including all main effects and two-factor interactions. The first