Krivitsky, P. N., Koehly, L. M., & Marcum, C. S. (2020). Exponential-Family Random Graph Models for Multi-Layer Networks. Psychometrika, 85(3), 630-659. <https://doi.org/10.1007/s11336-020-09720-7>

This article by Krivitsky et al. explores the complex terrain of multi-layer networks, which encompass various types of binary relationships among actors, conceptualized as layers. They extend traditional Exponential Random Graph Models (ERGMs) to accommodate the multi-layer structure of networks, offering a nuanced approach to understanding the interdependencies among different relationship types.

The authors advocate for joint modeling of multi-layer networks, emphasizing that this approach reveals contrasts and dependencies within the structural layers that could not be discerned when modeling layers separately. This methodological advancement is not without its challenges, as the complexity of multi-layer networks increases exponentially with each additional layer, necessitating hypothesis-driven models firmly rooted in theoretical underpinnings.

The paper acknowledges logistical and computational hurdles inherent in multi-layer network analysis. It reviews various strategies to address these complexities, such as the application of entropy measures, latent space analysis, data reduction techniques, and tensor algebra. These methods illuminate the structural interdependencies across layers and accommodate the multiplex and dynamic nature of relationships. Krivitsky and colleagues underscore the imperative for precision in model specification and the deployment of more sophisticated estimation methods, such as Markov Chain Monte Carlo (MCMC), to achieve accurate depictions of relational patterns.

Krivitsky et al.'s contribution is a cornerstone for researchers endeavoring to parse the entangled web of social interactions within multi-layered domains. Their work advances the field by providing methodological clarity and direction for those looking to unpack the complexities inherent in multi-layer networks, positioning it as a pivotal resource for our project's structural analysis of multi-relational networks.